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# VALUATION OF THE ENVIRONMENTAL GOODS AND SERVICES PROVIDED BY THE PÁRAMO DE SANTURBÁN

## FINAL REPORT

The AILEG Project

CONTRACT NUMBER: EEM-I-00-07-00004  
TASK ORDER NUMBER: AID-OAA-TO-11-00041

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Submitted to:  
**Office of Economic Policy**  
**Bureau for Economic Growth, Education and Environment**

Submitted by:  
**Abt Associates Inc.**

**April 2015**

#### **DISCLAIMER**

The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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# ACRONYMS AND ABBREVIATIONS

<b>CO<sub>2</sub></b>	Carbon dioxide
<b>DAP</b>	<i>Disponibilidad a Pagar</i> (Willingness to pay)
<b>GEIH</b>	<i>Gran Encuesta Integrada de Hogares</i> (Large Integrated Household Survey)
<b>GLM</b>	<i>Modelo Linear Generalizado</i> (Generalized linear model)
<b>ha</b>	Hectare
<b>IAA</b>	<i>Indice de Actitudes Ambientales</i> (Attitudes toward the Environment Index)
<b>ICBF</b>	<i>Instituto Colombiano de Bienestar Familiar</i> (Colombian Institute of Family Welfare)
<b>ICP</b>	<i>Índice de Conocimiento del Páramo</i> (Index of Páramo Knowledge)
<b>MDL</b>	<i>Mecanismo de Desarrollo Limpio</i> (Clean development mechanism)
<b>PSA</b>	<i>Pago por Servicios Ambientales</i> (Payment for environmental services)
<b>VET</b>	<i>Valor Económico Total</i> (Total economic value)

# EXECUTIVE SUMMARY

Páramos are high, cold plateau, mountain ecosystems between the tree line and the permanent snowline. Colombia is one of the few countries with this type of ecosystem, and the Andean páramo has unique attributes. While these ecosystems are located mainly in the northwest corner of South America—in Colombia, Ecuador, Peru, and Venezuela—páramos also occur in Central America.

In Colombia, the majority of páramo ecosystems are found in the Andes Mountains. They provide important environmental services, especially watershed management and biodiversity. Páramos also contribute to carbon sequestration and their unusual scenic beauty is important for recreational purposes.

The Páramo de Santurbán is vital for the regions of Santander and Norte de Santander in Colombia. It provides important water quantity and quality services and recreational space for neighboring towns and villages and nearby cities.

Recently, there has been controversy in Colombia over the conservation of the páramo ecosystem because of other conflicting economic activities, mainly gold mining. To help inform this debate, this study attempted to place an economic value on some of the environmental services of the Páramo de Santurbán. It addresses five key environmental services: water provision and regulation for residential consumption, recreation, carbon sequestration, existence value, and bequest value. After this report was completed, the Government of Colombia expressed an interest in further research on other economic values in agriculture, energy generation, and fisheries.

This study used a contingent valuation approach to value water provision and regulation services for residential water users in Bucaramanga, Cúcuta, and Pamplona—the three main cities in the area of influence of the Páramo de Santander. Contingent valuation is a survey-based economic technique for the valuation of non-market resources, such as environmental preservation, which have certain aspects that do not have a market price as they are not directly sold. The surveys conducted in these three cities asked respondents how much they would be willing to pay to protect the Páramo de Santurbán. The hypothetical payment vehicle was an increase in their bimonthly water utility bill.

Based on the data obtained through the surveys, the analysis developed a probit model to estimate the average willingness to pay (WTP) of these cities' residents for the water services provided by the páramo. A probit model is a type of statistical regression in which the response variable can only have two possible outcomes. In this particular case, such outcomes were whether the surveyed individual was willing or unwilling to pay for preservation of water quality and quantity.

The probit model was selected because contingent valuation studies often receive a considerable amount of protest responses— responses where individuals state a willingness to pay of zero, not because they do not value environmental services, but for other reasons (e.g., belief that environmental

protection is the government's responsibility, environmental services should not be commoditized). The probit model attempted to separate true willingness to pay zero from protest zeros. This would allow the study to provide insight into their determinants and impacts on willingness to pay. An alternative to using the probit model be to simply drop these observations. However, several studies found that such practice causes imprecise estimates of willingness to pay, particularly because protesters tend to be different from the rest of the surveyed population and because they do value the ecosystem services.<sup>1</sup> The probit model was selected over other binary response models, such as Logit, because it is based on the assumption of a standard normal distribution, which tends to be more realistic. The main difficulties with probit models are the difficulty in interpreting its coefficients and the requirement that all unobservable components have a normal distribution.

First, by extrapolating the average WTP obtained from the surveys, the value of the service ranged between COP 127 and 733 billion (US \$69.4 and \$400 million)<sup>2</sup>. This assessment only considers residential water users of these three cities and not the economic value of water for other sectors and populations. For this reason, it can be considered a lowest bound value for the water provision and regulation services of the Páramo de Santurbán.

Second, the travel cost method was used to value the recreational services. A sample of visitors to the Páramo de Santurbán was surveyed to collect information on their socioeconomic characteristics, expenditures on their visit, and attitudes on conservation of the site. The sample consisted of 140 individuals, 88 percent of whom were Colombian, with the remaining 12 percent from other countries. Travel costs ranged from COP 30,000 to 500,000 (US \$16 to \$275), with an average cost of COP 374,000 (US \$204). A linear travel cost model provided a lower bound estimate of the value of the recreational services of the Páramo de Santurbán of COP 9,592 million (US \$5.2 million) at a social discount rate of 12 percent. If the ecosystem is better preserved and more facilities are provided for visitors, the number of visitors would be expected to increase, therefore increasing the value of the services above this level. Population and income growth may also increase tourism over time.

Third, carbon sequestration was valued using a benefits transfer methodology. The total area of the páramo was taken into account, along with the estimated average carbon dioxide (CO<sub>2</sub>) sequestered from five páramos in other areas (based on previous research<sup>3</sup>). Based on a market value of US \$5 for a ton of carbon, the carbon sequestered in the Páramo de Santurbán has a value of US \$31.9 million or COP 58.3 billion. If the cost per ton of CO<sub>2</sub> is US \$2, then the value is US \$12.57 million or COP 23 billion.

Fourth, existence and bequest values were estimated as non-use benefits for the residents of Bogotá and Medellín, who do not receive direct services from the Páramo de Santurbán. Existence value reflects people's interest in conservation of specific natural resources, even if they have never visited and have no plans to visit them. In turn, bequest value reflects the desire of people to preserve the natural

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<sup>1</sup> For example, see Cho *et al.* 2008.

<sup>2</sup> This report uses an exchange rate of COP 1,829 = USD 1, which is the average rate for the period between January 1 and June 30, 2013, during which the study was prepared.

<sup>3</sup> Garcia Portilla, 2003; Hofstede, 1999; Rondón *et al.*, 2002;

resource for their descendants or, more broadly, future generations to use (Krutilla, 1967). The residents of these cities were surveyed; the average WTP in these cities is COP 31,335 (US \$17) per person, implying an aggregate value of COP 238 billion (US \$130 million). The significant existence and bequest values indicate that the cost of conserving these ecosystems could be financed by non-local populations within the country. The study did not consider the existence or bequest values for foreigners.

Adding these five types of values, a total economic value (TEV) of between COP 398 billion and 1.5 trillion was estimated (US \$217.6 and \$820 million). This lower bound value of the environmental services provided by Páramo de Santurbán can also be used for public policy discussions and the design of financing mechanisms for conservation, such as payments for environmental services (PES).

This paper also describes the population of the páramo area, including socio-demographic and economic characteristics, to help establish appropriate compensation schemes in case the area's conservation status is changed. A total of 250 household surveys were carried out in the páramo. The survey was conducted because the national census data uses municipalities as its main units, and specific data on the páramos population could not be extracted from it. This survey found that the Páramo de Santurbán was inhabited by a rural population, mainly dedicated to agricultural activities (50 percent) and some mining activities (10 percent).

The average monthly income of this population was COP 1,165,870 (US \$637) per month. However, households engaged in mining activities earned an average of COP 1,762,500 (US \$964) per month, compared to COP 1,124,051 (US \$615) per month for those in agricultural activities and COP 1,509,091 (US \$825) per month for those in livestock activities. This average masks high differences between household incomes, which ranged from COP 200,000 to 4,000,000 (US \$109 to \$2,187) per month.

The average household size was four, slightly above the national average of 3.8, where 33 percent of the population's highest level of education is primary school and 61 percent dropped out of high school. Fifty-four percent of people over 18 were workers; of these, 78 percent were male. Women were mostly engaged in household chores. About 58 percent of households participated in state programs called *Familias en Accion* (a cash transfer program that gives grants to poor households with children on the condition that children attend school and follow preventive health care measures) and *Adultos Mayores* (a program that provides economic subsidies to senior citizens who are without pensions, homeless, or in extreme poverty). Almost all households had electricity. Water and sewage coverage was 32.9 percent and 14.5 percent, respectively, with national levels at 53.1 percent and 12.3 percent, respectively.

Most farms were small—90 percent were less than 10 hectares (ha). The main crops were potatoes and onions, while the main livestock products were sheep and cattle. The households dedicated to mining activities extracted gold. On average, their annual sales amounted to 16.2 kg of gold per year, which generated a total income of COP 1,735,000,000 (US \$948,606).

# I. INTRODUCTION

The páramo's ecosystem extends discontinuously between latitudes 11 degrees north and 6 degrees south, mainly through Venezuela, Colombia, and Ecuador, with a few outcrops to the north in Costa Rica and Panama. The páramo consists of plains and rugged glacial valleys with lakes, marshes, and wet meadows.

The most relevant feature of the páramo's soil is its high capacity to regulate water. Its high water storage capacity is due to a combination of high porosity and high permeability (infiltration). In addition, the páramos provides biodiversity, recreation, and carbon sequestration services.

The Páramo de Santurbán is located in the departments of Santander (municipalities of Charta, Vetas, California, Suratá, and Tona) and Norte de Santander (municipalities of Abrego, Arboledas, Cáchira, Cécota, Chitagá, Cucutilla, La Esperanza, Labateca, Mutiscua, Pamplona, Pamplonita, and Toledo). It covers about 82,664 hectares (ha) between 3,000 and 4,290 meters above sea level.

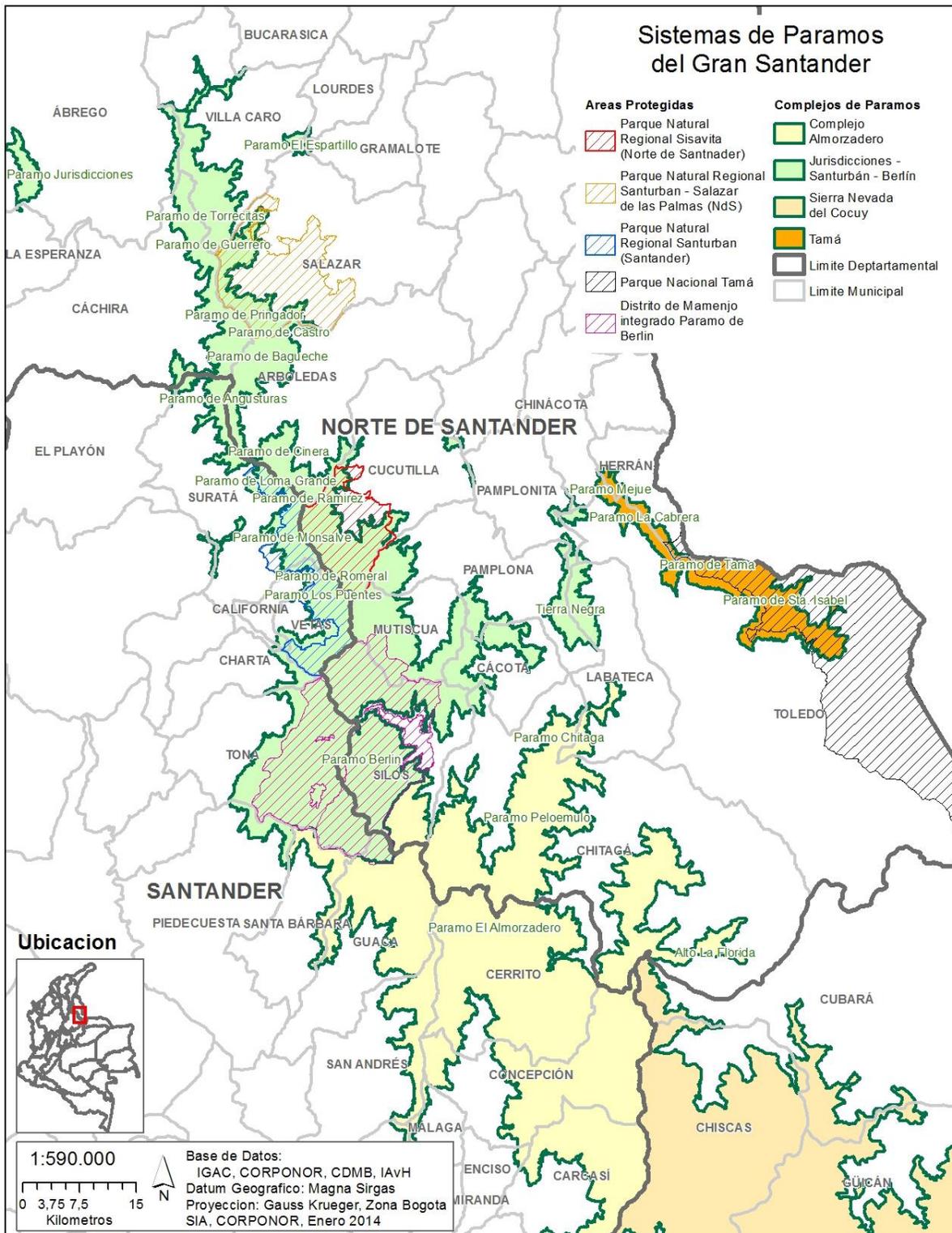
Around two-thirds of the area of this páramo (61,000 ha) is in the territory of the Autonomous Regional Corporation of the Northeast Frontier (Corponor). The remaining 21,553 ha are in the territory of the Autonomous Regional Corporation for the Defense of the Bucaramanga Plateau. Thirty-five percent of the total area of the Páramo de Santurbán is used for crops or pastures. The municipalities with the highest converted areas are Tona (whose urban area is within the boundaries of the complex), Mutiscua, Cécota, and Silos. Natural ecosystems occupy 53,800 ha of the total area of the Páramo de Santurbán; the most representative among these ecosystems is in the páramo, which represents 50 percent of the area (IAVH 2007).

The Santurbán complex includes the basin areas of the Caribbean, the Magdalena, the Cauca, and the Orinoco. It is divided into the areas of the Catatumbo, Medio Magdalena, and Arauca rivers and seven sub-watershed areas, including the Zulia, Lebrija, and Chitagá rivers. This páramo is a recharge and retention zone for surface water and groundwater. It is the source of water for 48 municipalities—15 in Santander and 33 in Norte de Santander, serving an estimated population of 2.3 million. Santurbán also supplies water to the Tasajero power plant, the aqueducts of Cúcuta and its metropolitan area, production and processing of thousands of ha of coffee, and 10,000 ha of rice in the Zulia irrigation district. The Santurbán will also provide water for the future expansion of Phase II of a multipurpose reservoir in the Cínera and Termotasajer. In Santander, the Santurbán provides water for all economic development in the Bucaramanga Metropolitan Area, as well as the mining sector, which began as an artisanal activity over a century ago, but now includes large multi-nationals. Most of the mining in the region has been legal, but illegal mining activities have reportedly increased in the last few years.<sup>4</sup>

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<sup>4</sup> See “Minería ilegal se toma una zona de Santurban”, Portafolio, February 5, 2014. <http://www.portafolio.co/economia/mineria-ilegal-zona-santurban>

Figure I: Map of the Páramo de Santurbán Area



Source: [http://commons.wikimedia.org/wiki/File:Sistemas\\_de\\_Paramos\\_del\\_Gran\\_Santander\\_-\\_Santurbán,\\_Almorzadero,\\_Tam%C3%A1](http://commons.wikimedia.org/wiki/File:Sistemas_de_Paramos_del_Gran_Santander_-_Santurbán,_Almorzadero,_Tam%C3%A1)

In addition, the Santurbán complex is rich in flora, fauna, and microbiota and has high potential for ecotourism (Corponor 2009). The Government of Colombia has designated several parks within the Páramo de Santurbán, including the Natural Regional Par Páramo de Sisivita (covering 12,248 ha), the Páramo de Berlín Integrated Management District (with a surface of 44,273 ha), and the Complejo Lagunario del Norte, which has a total of 40 lagoons. The Lagunas del Norte is located in the municipalities of Cáchira, Salazar, and Arboledas. Lagunas del Sur is in the municipalities of Vetas, and Muticua.

In addition to its wealth as an ecosystem, the Páramo de Santurbán is rich in gold and other minerals. The municipalities of Vetas and California are historic mining areas. Over the last decade, an increase in the price of minerals caused large mining companies to enter the area, raising civil society organizations' concerns about wilderness protection. Although there is no public information on the size of the remaining gold reserves, data from mining projects suggest that they are substantial. By early 2011, Greystar Resources, a Canadian mining firm, was about to begin a new mining project in the municipality of California with a potential of 7.7 million ounces of gold, and an annual production of 511,000 ounces of gold.<sup>5</sup> To put these numbers in perspective, Colombia produced a total of 1,580,189 ounces of gold in 2011 nationwide.<sup>6</sup>

Miners, farmers, water users, and environmentalists have conflicting goals that surfaced in the debate on the Regional National Park of Santurbán declaration of January 2013. The park has a total area of 11,700 ha, but this declaration caused considerable discontent among miners and farmer because of political difficulties in defining the Regional Natural Park's borders. Under the declaration, mining activities are expressly prohibited within the park's boundaries. While existing residents will be allowed to continue living in the park boundaries, they will no longer be able to continue with their agricultural activities. Instead, they are expected to undertake conservation activities and receive an income from the Payment for Environmental Services mechanism, funded through contributions from water users in Bucaramanga.<sup>7</sup> Environmentalists believe the protected area is not sufficient in size, while those living in the park and conducting economic activities are uncertain they will receive any compensation.

Further economic development of this páramo inside and outside the park may endanger the area's biodiversity and the water quality and quantity received by residents in Bucaramanga, Cúcuta, and 22 other municipalities. Protecting the páramo is also important because this type of ecosystem exists in only a few countries worldwide.

The objective of this paper is to estimate the value of certain environmental services provided by the Páramo de Santurbán. Valuation of the resource allows future funding strategies to be set and provides guidance on whether a conservation fee would be seen as acceptable by taxpayers and

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<sup>5</sup> See "Más de 29 millones de onzas de oro en Colombia, a la espera de que las exploten.", January 11, 2011. <http://www.portafolio.co/tres-minas-oro-esperan-ser-explotadas>

<sup>6</sup> Marta Bernal González. "Minería de oro en Colombia: auge y problemática." Revista de Logística <http://www.revistadelogistica.com/Mineria-de-oro-en-Colombia-auge-y-problematica.asp>

<sup>7</sup> ¿Qué pasará con el Páramo de Santurbán, tras ser declarado parque natural? January 9, 2013. <http://www.elpais.com.co/elpais/colombia/noticias/pasara-con-paramo-santurban-tras-ser-declarado-parque-natural>

water ratepayers. Five types of environmental services were valued—three “use” values and two “non-use” values. The use values included residential water provision and regulation services, recreation, and carbon sequestration. The non-use values included existence and bequest values.

After this report was completed, the Government of Colombia expressed an interest in further research on other economic values in agriculture, energy generation, and fisheries.

## 2. VALUATION OF ECO-SYSTEM SERVICES

The environment provides numerous direct and indirect services to people and communities. However, as public goods, many of these services have no market price. For estimation purposes, economists have developed techniques to attribute values for these environmental goods and services.

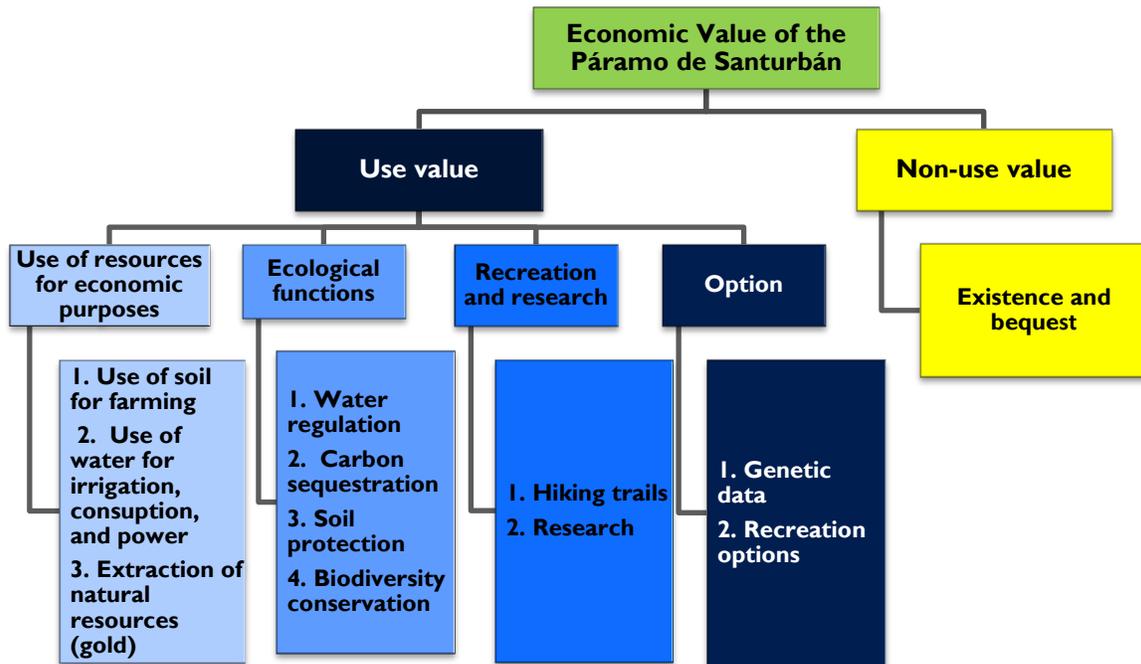
Environmental goods and services can be divided into use values and non-use values. Use value is an economic value based on the tangible human use of an environmental or natural resource (EPA 2014). They are divided into direct use values, indirect use values, and option values. Direct use value refers to ecosystem goods and services that are used directly by humans and can be consumptive or non-consumptive. Examples of consumptive use include harvesting of food products, timber for fuel or construction, vegetation for medicinal products, and hunting of animals for consumption. Examples of non-consumptive direct use include the enjoyment of recreational and cultural activities—given that they do not involve harvesting of products (Pagiola et al. 2004).

Indirect use values are derived from ecosystem services that provide benefits outside the ecosystem itself, such as climate regulation and nutrient and waste recycling. Option values are derived from forgoing the use of ecosystem goods and services at the current moment to preserve the option for future use by oneself or others. A quasi-option value reflects the net benefit of postponing a decision to use a resource while more information is collected (Arrow and Fisher 1974).

Non-use or passive values refer to the value an individual may derive from a good or resource without consuming it. Bequest and existence values are examples of non-use values. Bequest values refer to the value that an individual places on the availability of a resource for future generations. Existence values are the value people may place on the mere knowledge of the existence of a good or resource (EPA 2014).

The total economic value (TEV) is the total value of goods and ecosystem services, i.e., the sum of the use values and non-use values (TEV = use value + non-use value).

**Figure 2: Economic Value of Goods and Services Provided by the Páramo de Santurbán**



Source: Own data

There are two main approaches to valuing environmental services—revealed preference methods and stated preference methods (Mitchell and Carson 1989). Revealed preference methods use consumers’ behavior to derive the values they assign to these environmental assets. Stated preference methods try to create hypothetical prices based on what people say they are willing to pay for the conservation of natural resources or the improvement of environmental quality.

Both revealed preference and stated preference methods are used in this study.

# 3. WATER PROVISION AND REGULATION VALUATION

## 3.1. INTRODUCTION

The main environmental service provided by the páramos is the provision and regulation of water. The Páramo de Santurbán provides water for approximately 2.3 million people and supports economic activities such as agriculture and hydropower. This section uses the revealed preference approach to estimate the willingness to pay of the residents of three cities—Bucaramanga, Cúcuta, and Pamplona—for preserving the quantity and quality of water from the Páramo de Santurbán.

## 3.2. METHODS

The contingent valuation method estimated the value of residential water quantity and quality. The contingent valuation method is a stated preference approach that simulates market pricing by asking potential consumers about the maximum amount they would be willing to pay for the resource. It is called contingent valuation because individuals' willingness to pay depends on the hypothetical scenario proposed by the interviewer.

Contingent valuation attempts to estimate these values through surveys or games. Participants with low levels of education may find the purpose hard to understand. Some respondents may give answers that they think will either please or confound the surveyors (instrumental bias). Participants are aware that these exercises are not actually used to set actual payment or compensation amounts, which sometimes causes their responses to be similarly hypothetical and reflect some proportion of disposable income. Furthermore, if participants thought the exercise was real, they would have an economic incentive to make statements that distort their true values (strategic bias).

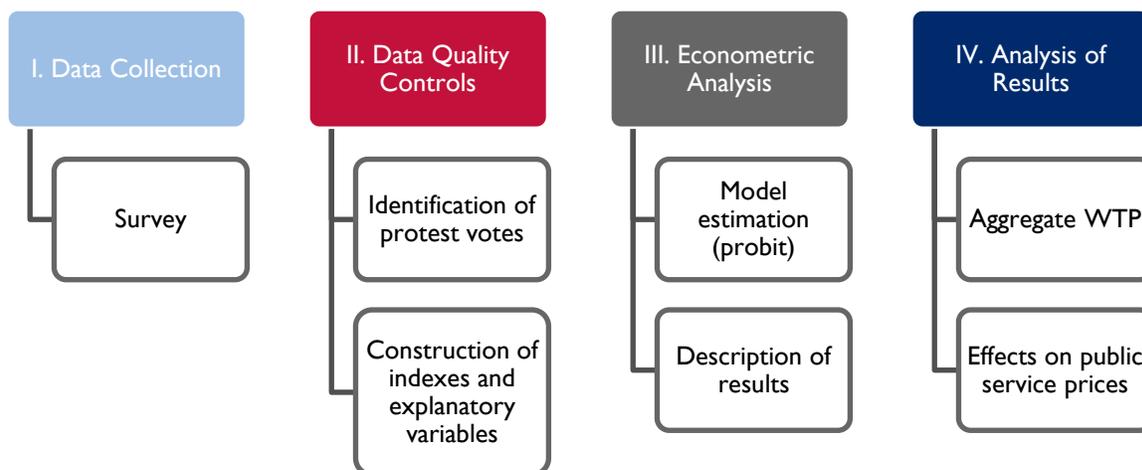
The surveys also gathered information on the characteristics of the respondents to determine what makes an individual more willing to pay to preserve the quantity and quality of water from the Páramo de Santurbán.

In theory, an individual should be more willing to pay when this individual benefits (i.e., has greater utility) from payment to maintain or improve the level of the environmental service; this must be more beneficial than if the resource is not available. However, the WTP depends on the ability to pay, which varies with socioeconomic and demographic characteristics. The stated WTP may also vary with the respondents' expectations about whether they actually would have to pay, the payment vehicle used, and whether the money would be used effectively to preserve the resource.

An important issue in contingent valuation is whether respondents should be asked about the minimum amount they would be willing to accept (WTA) as compensation for the loss of a resource. In practice, there are often large differences between stated WTP and WTA values.

Figure 3 describes the contingent valuation method used in this study.

**Figure 3: Contingent Valuation Methodology for Water Provision and Regulation**



Source: Own data

Respondents were asked the following open-ended question:

*To preserve the quantity and quality of the water you receive, it is necessary to protect its sources in the Páramo de Santurbán, which implies increased funding by users. How much more are you willing to pay on each water services bill, in addition to what you currently pay?*

This study did not use the more complicated “bidding game” approach, which often yields higher willingness to pay values.

Respondents were divided into two groups based on their answers. The first group included people who expressed their willingness to make a monetary payment as well as those who said they were not willing to pay. The second group consisted of 242 respondents who agreed that the Páramo had value, but were not willing to pay because they rejected the approach of treating public goods as market items. Since these respondents had an unknown, but non-zero value on the resource, the study assumed that they would place the same value on the resource as the median of those willing to make a monetary payment: 1,000 pesos. In addition, a sensitivity analyses was made on this assumption, with WTP of the “protest respondents” valued at 2,000, 3,000 and 4,000 pesos.

Then, the mean WTP value was calculated based on the results of a probit model, in which the dependent variable was set equal to one if the respondent was willing to pay for the resource and zero if not.

$$WTP(YES = 1; NO = 0) = f(P, \Phi, \Omega, \Psi, \Upsilon) \quad (1)$$

Where:

$P$  Dollar value (price) that the respondents were willing to pay (zero for those not willing to pay and the median value “ $i$ ” for protest respondents)

$\Phi$  Social and demographic variables such as nationality, place of residence, education level, social stratum, and occupation

$\Omega$  Income

$\Psi$  Knowledge, perceptions, and attitudes on water consumption of the Páramo de Santurbán

$\Upsilon$  Knowledge, perceptions, and attitudes toward ecosystem services of the Páramo

The average WTP was calculated as follows:

$$E(WTP) = -\frac{\alpha_i}{\beta} \bar{Z}_i \quad (2)$$

Where:

$\bar{Z}_i$ , is the average values of the explanatory variables.

$\alpha_i$  is the set of coefficients of the independent variables, including the intercept

$\beta$  is the coefficient of the monetary willingness to pay

The next stage of the study drew on results from two other sources—the 2012 household survey in Bucaramanga and Cúcuta and the 2005 census projection for Pamplona. The total population between the ages of 17 and 85 was 829,523 people. Then, the WTP was compared to the household’s current bimonthly water bill, excluding sewage and garbage collection services.

### 3.3. RESULTS

Using a probit model, four models were estimated with different WTP values imputed for the protest votes. A probit model is a type of statistical regression in which the response variable can only have two possible outcomes. In this particular case, such outcomes were whether the surveyed individual was willing or unwilling to pay for the ecosystem services. The probit model was selected because contingent valuation studies often receive a considerable amount of protest responses, that is, responses in which individuals state a willingness to pay of zero, not because they do not value environmental services, but for other reasons such as their belief that environmental protection is the government’s responsibility or that environmental services should not be commoditized. The probit model served to separate true willingness to pay of zero from protest zeros.

The main model assumes that protest respondents place a value on the páramo equal to the WTP median of those willing to make a monetary payment. Models 2, 3, and 4 are sensitivity exercises with values of 2,000, 3,000, and 4,000 pesos assigned to protest votes, respectively. The WTP of respondents in the three cities was then related to income, the perception of water quality, and

the Index of Páramo Knowledge (ICP)<sup>8</sup>. The following variables were significant: income at the 0.05 percent level in the four models; perception of water quality at the 0.01 percent level in three of the four models; and ICP at the 0.01 percent level in all four models. The proportion of children in the household was significant at the 0.05 level in two models and at the 0.01 percent level in one model, while the number of uses of water from the páramo was significant at the 0.05 percent level in one model and at the 0.10 percent level in another model. These results suggest that the WTP is associated with the individuals' longer term perspectives, such as having children that would benefit from continuing to have water availability when they grow up.

The WTP was positively associated with the perceived water quality consumed in the home, knowledge about the páramos, and a larger number of uses for water resources. Surprisingly, higher income was associated with a lower willingness to pay for the ecosystem's conservation.

The price coefficient is positive, meaning that the probability that an individual will be willing to pay increases as the monetary value of such payment also increases. This is somewhat unexpected and could have resulted from the way the valuation question was formulated. The question was not a referendum, where the respondent is a price-taker; rather, it was an open-ended question where the respondent determined the price of the public good. Therefore, it is understandable that a person who declared a higher WTP also had other characteristics that made him more likely to make a payment.<sup>9</sup> However, the effect of this variable, although significant, is very small.

Since the coefficients of a probit model cannot be interpreted directly, Table I presents the marginal effects of the variables of the models. As discussed earlier, the probit model aimed to assess the probability that the individual was willing to either pay or not pay a non-zero amount for the preservation of water quality and quantity. To give an indication of how these effects should be interpreted, we will use the value of the variable "income", under the main scenario that has a value of 1,000 pesos for protest votes. This variable has a value of -0.0306. Because this value is negative, any change in the variable "income" is associated with a change in the opposite direction of the probability that the individual was willing to pay. Also, these numbers should be multiplied by 100 to obtain the value of the change in probability associated with a change of one unit of income, holding all the other variables constant. Thus, as income increased by one unit, the probability of one's willingness to pay decreased by 3 percent, under the main scenario and holding all other variables constant.

Under the main scenario, a better perception of water quality increased the probability of being willing to pay by 3.6 percent. Similarly, a better understanding of the páramo and its environmental services increased the likelihood of a positive WTP by 8.7 percent. The variable with the greatest effect on the probability of payment was the proportion of children in the household. The

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<sup>8</sup>See Annex 11.2.

<sup>9</sup> This might also be explained by respondent bias, including hypothetical bias (when values elicited in a hypothetical context differ from those elicited in a real context). See Diamond and Hausman (1994).

addition of one child in the household increased the probability of paying for preservation by 25 percent under scenarios 2, 3, and 4.

**Table 1: Probit Valuation Model: Fixed Effects**

	(1) (1,000 Pesos)	(2) (2,000 Pesos)	(3) (3,000 Pesos)	(4) (4,000 Pesos)
Willingness to pay (WTP)	0.000236*** (4.17e-05)	0.000206*** (1.70e-05)	0.000106*** (9.80e-06)	6.21e-05*** (7.13e-06)
Income	-0.0306** (0.0155)	-0.0607** (0.0284)	-0.0527** (0.0252)	-0.0464** (0.0231)
Perception of the quality of water	0.0361** (0.0153)	0.0784*** (0.0265)	0.0754*** (0.0239)	0.0673*** (0.0220)
Index of Páramo Knowledge (ICP)	0.0875*** (0.0275)	0.175*** (0.0370)	0.149*** (0.0322)	0.140*** (0.0298)
No. children/No. household members		0.253** (0.117)	0.258** (0.104)	0.259*** (0.0963)
Number of uses of water	0.0644 (0.0425)		0.129* (0.0685)	0.138** (0.0654)
Observations	609	609	609	609
*** p<0.01, ** p<0.05, * p<0.1				

Note: The value in parenthesis is the robust standard error.

Building on the probit model, the expected value of the WTP through an additional charge in the bimonthly water bill was calculated for an average household (equation 2). Table 2 shows that the

average WTP ranged from 3,066 and 17,686 pesos bimonthly, depending on the assumed value of the protest responses.

These values represent at least 5 percent of the average bimonthly water service bill (excluding sewer and garbage collection services) and at most 28.8 percent of the bill for Bucaramanga and Cúcuta.<sup>10</sup> The percent increase in the water bill, on average, would be the greater for lower-income households, who have lower bills because of higher subsidies and lower water costs.

**Table 2: Average Annual, Incremental Willingness to Pay**

	<b>Value Assigned to Protest Vote (Pesos)</b>	<b>Average Annual, Incremental Willingness to Pay (Pesos)</b>
<b>Scenario 1</b>	1,000	3,066
<b>Scenario 2</b>	2,000	6,180
<b>Scenario 3</b>	3,000	11,461
<b>Scenario 4</b>	4,000	17,686

These results were extrapolated from the sample to the population using the 2012 Household Integrated Survey for Bucaramanga and Cúcuta and the 2005–2012 census projection for Pamplona. In total, the annual WTP in these three cities is 15,260 million pesos under Scenario 1 (and a maximum of 88.026 million pesos for Scenario 4).

Table 3 extends these annual values in perpetuity, using a discount rate of 12 percent per annum. The present value of the aggregated WTP ranged from 127 billion pesos in Scenario 1 to 733 billion pesos in Scenario 4. The following table presents the results for the four scenarios proposed. Although perpetuity really exists only as a mathematical model, it is used in this analysis to approximate the value of a long-term stream of equal payments, even though the discounting effects mean that payments in the distant future do not have an important effect in the present value. It is important to note that the present value estimated here is a very conservative estimate, as it does not take into account the population and income growth that are expected to take place over the coming years, nor the likely increase in water scarcity. Table 3 also shows how the present value of aggregate WTP increases when lower discount rates are used, thus reflecting a higher valuation of the benefits that will be received in the future. As table 3 indicates, the present value of aggregated WTP would be between 508,663 in Scenario 1 and 2,934,189 million pesos in Scenario 4. This sensitivity analysis illustrates how present values can change, depending on a society's preference for present consumption over future consumption.

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<sup>10</sup> To see the results per income level for these two cities, go to 11.4.

**Table 3: Aggregated Willingness to Pay**

				<b>WTP Aggregated to Perpetuity</b>		
	Value Assigned to the Protest Votes (Pesos)	Average Willingness to Pay (WTP) (Pesos)	Annual Aggregated WTP (Million Pesos)	At a 12% discount rate (Million Pesos)	At a 7% discount rate (Million Pesos)	At a 3% discount rate (Million Pesos)
<b>Scenario 1</b>	1,000	3,066	15,259.90	127,166	217,999	508,663
<b>Scenario 2</b>	2,000	6,180	30,758.71	256,323	439,410	1,025,290
<b>Scenario 3</b>	3,000	11,461	57,042.97	475,358	814,900	1,901,432
<b>Scenario 4</b>	4,000	17,686	88,025.66	733,547	1,257,509	2,934,189

### 3.4. CONCLUSIONS

This assessment only considers residential water users in Bucaramanga, Cúcuta, and Pamplona. It does not include the value of water from the páramo for other sectors and populations. For this reason, it is a lower bound estimate of the value of water provision and regulation services provided by the Páramo de Santurbán.

The variables that increase the reported likelihood of making a payment to protect water quality and quantity are related to individuals' medium-term goals, which included the presence of children in the household, knowledge about the Páramo de Santurbán, and perceptions of the quality of household drinking water. It is important to note that the survey's findings would suggest that social stratum does not play a role in the willingness to pay and that income has a negative effect.

These results shed light on possible funding mechanisms for the protection and conservation of the Páramo de Santurbán. A payment for environmental services (PES) scheme could be funded through the water bill. An annual payment of 3,000 pesos would be acceptable to a large part of the population, considering that 66% of the surveyed population was willing to make a payment and this amount represents the minimum WTP estimated in this analysis. Part of the funds generated should be devoted to education programs about the páramos since they would increase people's willingness to pay over time. Similarly, improvements in perceptions about the quality of water services have an effect on the sustainability of the PES scheme for the conservation of the Páramo de Santurbán. Another alternative would be to establish a proportional charge per socio-economic stratum, according to the values obtained in the study. An acceptable minimum would be 5 percent of the water bill.

## 4. RECREATION VALUE

### 4.1. INTRODUCTION

Recreation is one of the key ecosystem services provided by the páramos. The Páramo de Santurbán has more than 80 natural lagoons located between 3,500 and 4,385 meters above sea level. It has a rich fauna and 64 recorded species of *frailejones* (a genus of perennial subshrubs in the family *Asteraceae*, with many endemic to the region). The area is also home to deer, red foxes, native condors, cougars, and black trout. Approximately 35 percent of the páramo is disturbed, meaning that it is used for agriculture and grazing or it is predominantly covered by secondary vegetation. The remaining 65 percent of the páramo is covered by primary vegetation and well preserved habitats (IAVH, 2008). It attracts tourists seeking direct contact and outdoor activities in this natural environment.

The Regional Natural Park Sisavita, established in 2008, covers only about 12,000 ha of the more than 82,600 ha of the Páramo de Santurbán.<sup>11</sup> Largely because of its formal designation as a natural park, the Regional Natural Park Sisavita has some of the most pristine ecosystems, which attract an important number of visitors. Although there are no official statistics, entry fees, or other formal visitor records for this park, a survey was conducted as part of this study, which indicates that around 7,400 people visit the park every year. This figure is reasonable considering the available data on the numbers of visitors to other páramos in the country that are regional natural parks. For example, the Chingaza Park located near Bogotá received 13,809 visitors in 2012 (MADS y PNN 2013).

Based on the above, this section estimates the economic value of the recreational services enjoyed by the people who visit the Páramo de Santurbán. To this end, a survey was administered to a sample of 140 visitors to the Páramo de Santurbán to collect information on the socio-economic characteristics of visitors, trip characteristics, travel costs, and attitudes toward the conservation of the ecosystem.

### 4.2. TRAVEL COST METHOD

The travel cost methodology estimates the economic benefits of unpriced scenic ecosystems indirectly. People spend money to visit natural areas for recreational activities, as these visits produce a sense of well-being. According to economic theory, the minimum benefit that an individual obtains from visiting a natural area must at least equal the travel costs incurred. By considering different travel costs incurred by visitors to the páramo from diverse places of origin, we are able to derive the demand for visiting this natural area (Parson 2003; Wieland & Horowitz 2007). The money that individuals spend to travel to a natural area can be used as a proxy for the value of the recreational experience. Some parks and protected areas have entry fees that

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<sup>11</sup> The Government of Colombia established the Regional Natural Park Santurban Salazar de las Palmas in December 2013, after the completion of this study. The park has an area of about 19,000 hectares.

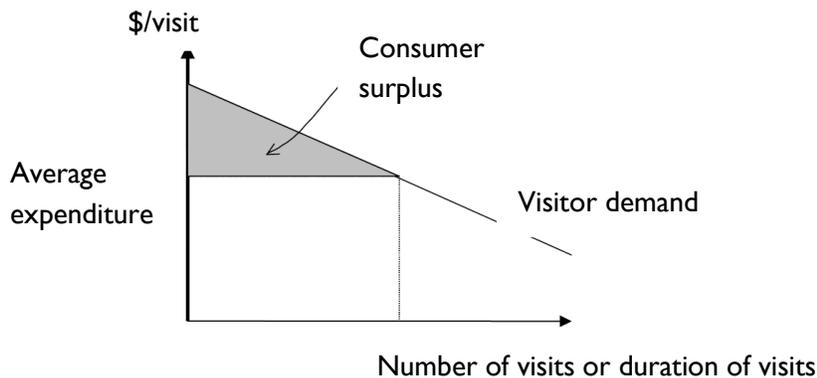
comprise part of the travel costs, but many are unpriced, as is the case of the Sisavita Regional Park.

Some studies have also placed a value on the time spent on the visit based on the opportunity cost of labor (foregone earnings) (MAVDT 2003). However, counting an opportunity cost for leisure time is controversial because the likely alternative is other leisure activities, rather than economically productive work. In fact, if people enjoy the journey, the travel time is a benefit rather than a cost (Mendes 2002; Wieland and Horowitz 2007). To address this issue, this study developed estimates both with and without considering the opportunity cost of labor, as discussed in the following section.

Travel costs underestimate the full value of the scenic resource because visitors might have been willing to pay more than the actual costs if they had to do so. These additional benefits are counted in the economic concept of consumer surplus. Consumer surplus is the difference between the maximum willingness to pay of users of a good or service and the amount actually paid.<sup>12</sup> Consumer surplus is calculated as the area under the demand curve above the price of a marketed good or proxy travel cost. Although some simplified travel cost applications have only counted the actual travel costs of visitors (which underestimates the total benefits), the complete method involves estimating a demand curve and calculating the larger consumer surplus.

A demand curve can be estimated for an individual visitor and aggregated across all visitors. An individual visiting the region  $r$  times in a certain period of time may face travel costs and park entry fees ( $c$ ). The value of the experience also depends on the park's environmental quality ( $q$ ). The aggregate demand also varies with the social and economic characteristics of the visitor(s) (Carriazo, Ibanez, and Garcia 2003). Thus, the demand for park visits can be shown by  $D = r(c, q, s)$ .

**Figure 4: Benefits for Recreation**



Source: Carriazo, Ibañez and García, 2002

<sup>12</sup> Often spelled consumers' surplus.

Some additional assumptions of the travel cost method are: 1) each recreational trip has a single purpose that is not combined with another stop, 2) visitors react the same way to an increase in the cost of travel and an increase in the entry fee; 3) travel costs to the site are greater than zero, and 4) there are no scenic or non-use benefits to people who do not travel to the site. There are several advantages of the travel cost method. First, it is based on revealed preferences, which are observed rather than hypothetical behaviors. Second, the method is inexpensive and the data can be obtained through on-site surveys with the potential for a large sample size since visitors are often interested in participating, and the results are relatively easy to interpret and explain (Maradan 2011).

The travel cost method also has some complications: 1) the issue of valuing the cost of time spent, 2) only some visitors spend the night at the site, 3) how to handle multiple destinations, and 4) evaluating the quality of the recreational experience and relating it to environmental quality (Maradan 2011).

Various equations can be used to capture the relationship between the number of visits by an individual and the cost of the trip. Wieland and Horowitz (2007) proposed modeling the natural logarithm of the number of visits per year as a linear function of the costs of travel and the individual characteristics of the visitor. This method can be used when an individual has made more than one visit to the same site.

$$\ln y = \alpha C + X\beta + \varepsilon$$

Where:

$y$  = the number of trips made by the individual per period

$C$  = the cost per trip

$X$  = the individual characteristics of the visitors

$\varepsilon$  = the normally distributed error

$$C = C_v + C_T$$

$C_v$  = Cost of travel (distance multiplied by travel cost per unit distance)

$C_T$  = Opportunity cost of time spent on travel (may be valued at the salary or wage rate or considered to be zero)

The coefficient  $\alpha$  is the disutility associated with the cost and is included as a negative number. The annual consumer surplus of all trips made by the individual,  $i$ , is:

$$S_i = -\frac{y_i}{\alpha}$$

The consumer surplus per trip is  $-\frac{1}{\alpha}$ .

### **4.2.1 Zonal Travel Cost Method**

The most common application of the travel cost method groups visitors by zones that represent ranges of distance traveled. The zonal travel cost method was used for the Páramo de Santurbán because surveys showed that most respondents were first-time visitors to the site, so the travel demand of these individuals could not be estimated.

The zonal travel cost method uses information on the number of visits to the site from different distance bands. It is based on the assumption that travel costs increase with distance, so that the number of visits by individuals from each zone can be related to the travel costs from the zone (prices). This information is used to estimate the demand function and consumer surplus (Ecosystem Valuation n.a.). The travel costs, and hence demand costs, are based on zone averages (Azqueta 1994).

## **4.3. RESULTS**

The zonal travel cost method was applied with in-person survey data from 140 sets of visitors to the Páramo de Santurbán. Survey days were chosen randomly and interviews were conducted in areas of high visitor traffic. Visitors were given a short questionnaire that took about five minutes to complete.

The surveys were carried out in the municipalities of Pamplona, Cúcota, Cúcira, Cucutilla, Vetas, and Suratá because they were either part of the páramo or were close to access points for lakes and other attractions.

The survey included background questions on the visitor's place of residence, age, range of monthly income, education, and main occupation. It also asked for information on the visitor's travel costs to the site, the number of visits to the Páramo de Santurbán over the last two years, the starting location, type of transport used, travel time, number of people traveling together, duration of the visit, main reason for the trip, and activities carried out (see Annex 11.5 for more details on the survey).

Based on the survey data, visitors were grouped into zones of origin. Visit rates, demand functions, and consumer surplus were estimated for each zone.

The municipalities closest to the páramo were analyzed separately and not grouped together. A total of 17 areas were identified for the study (see figure 5). The more distant zones had fewer respondents.

**Figure 5: Places of Origin**



The visits were disaggregated by weekdays (Monday through Friday) and weekends (Saturday and Sunday) to differentiate between people traveling for vacation and those simply visiting over the weekend. It was assumed that the number of visits per year would follow the pattern of the visits in the sample, resulting in a total of around 7,400 visitors a year. This figure does not consider that people might travel more or less during different seasons. The survey was conducted during December 2012 and thus, the estimated number of visitors may be inaccurate if travel during the other months of the year differs significantly from travel during the month of December. However, the scope of this study did not consider conducting surveys during different seasons and there were no other sources of information that would support an assessment of the seasonality of visits to the páramo, as there is currently no system in place to register visitors to the páramo. The total number of visitors was distributed by the zone of origin. Then, the number of visitors

from each zone was divided by the number of residents and multiplied by 100,000 to obtain the rate of visits per 100,000 residents.

In order to check the consistency of the economic values obtained from the survey, the study also estimated travel and time costs based on existing secondary sources. The average distance of each zone to the Páramo de Santurbán was calculated. A travel cost of 405 pesos per kilometer was assumed based on freight costs reported by the Ministry of Transport for Bogotá–Bucaramanga, Medellín–Bucaramanga, and Cúcuta–Bucaramanga.<sup>13</sup>

Since the roads in Colombia are not homogeneous and many are not paved, the study did not assume an average time per kilometer. The average travel time to the Páramo de Santurbán was approximated by asking visitors about the estimated travel time of public fleet services and using Google Navigate. Data on travel times between the towns near the páramo were obtained from people who live in the area and travel there frequently.

To calculate the cost of time, a total amount of 2,435.61 pesos per hour was set. This figure was used to assess the time for a transport study in Colombia that took into account an average monthly income of the population of Bogotá (EMBARQ 2009). Table 4 presents the results per area.

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<sup>13</sup>Available at: <https://www.mintransporte.gov.co/publicaciones.php?id=359>

**Table 4: Travel Cost per Zone**

Zone	Distance (Km)	Time <sup>a</sup> (Hours)	Travel Cost (Pesos)	Cost of Travel Time (Pesos)	Total Cost (Pesos)
Bogotá	921	21	373,046	50,904	423,950
Medellín	952	21	385,560	51,635	437,195
Bucaramanga	207	8	83,835	18,930	102,795
Cali	1,590	33	643,950	80,862	724,812
Caracas	2,054	82	831,870	200,110	1,031,980
Cúcuta	247	9	100,035	21,709	121,761
Duitama/Sogamoso	760	19	307,800	46,642	354,442
El Zulia	300	12	121,500	28,010	149,510
Los Patios/Villa del Rosario	373	13	151,065	31,216	182,281
Montería	1,540	30	623,700	73,637	697,337
Barranquilla	1,260	23	510,300	56,019	566,319
Pamplona	110	5	44,550	11,485	56,222
Ibagué/Pereira	1,453	29	588,465	71,810	660,275
Tunja/Vélez	612	17	266,606	40,854	307,460
Betulia	270	16	109,431	38,564	147,995
San Cristóbal/San Antonio/Ureña	348	14	139,320	33,514	172,834
Puerto Wilches	392	16	158,760	38,564	197,324

<sup>a</sup> Round trip. All figures are rounded, which may result in minor discrepancies.

#### 4.3.1 Estimation of Demand

A demand estimates was calculated based the median average travel cost reported by visitors. In order to check the validity of these results, the study also calculated two additional demand estimates: (1) the travel and time cost, and (2) travel cost only.

Table 5 shows the results of the three travel demand estimates by zone. The travel cost coefficient had a negative sign, as expected. It was significant at a 99 percent confident level under the first two models, but not for the third model based on the visitors' self-reporting. The numbers in the table indicate the change in visit rates (expressed as a percentage) that would be associated with a 1,000 increase in any of the variables, holding the rest of the variables constant. For example, as shown in the second row, third column, a 1,000 peso increase in travel and time cost was associated with a 0.63 percent decrease (stated as “-0.00627”) in the visit rate. A 1,000 peso increase in just the travel cost was associated with a 0.73 percent decrease in the visit rate (stated as “-0.00732” in the ninth row, fourth column). The other variables (average income, willingness to pay to visit a hypothetical natural park, and the main destination) were not significant in explaining the number of visits. A possible explanation for this may be that the variance of these other variables was lost in averaging characteristics across the zones.

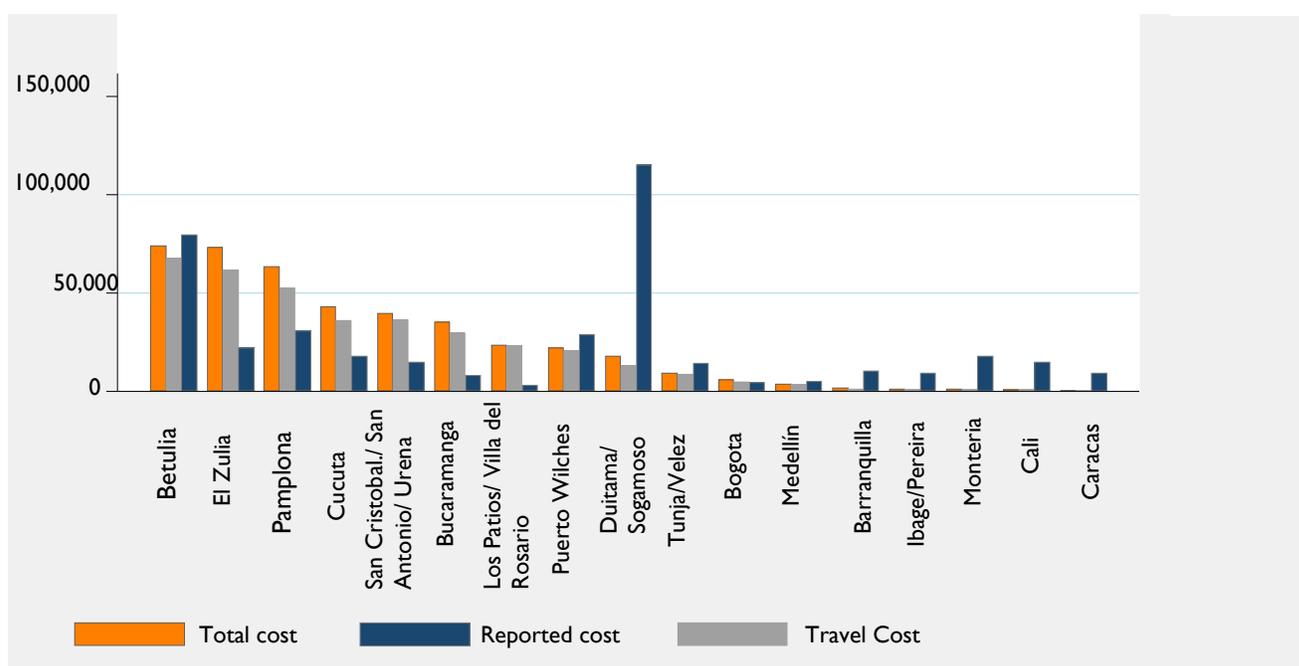
**Table 5: Travel Demand Estimate by Zone**

<b>Dependent Variable</b>	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>
<b>Natural Log Visit Rate</b>	<b>Average Reported Cost</b>	<b>Travel and Time Cost</b>	<b>Travel Cost</b>
Total Cost		-0.00627*** (0.000927)	
Income	-1.027 (0.695)	-0.321 (0.342)	-0.230 (0.340)
Willingness to Pay an Entrance Fee to the Park	1.970 (2.070)	1.222 (0.927)	1.058 (0.911)
Main Destination Páramo (Dummy)	-0.877 (1.388)	-0.416 (0.664)	-0.461 (0.652)
Cost of Trip			-0.00732*** (0.00106)
Cost Reported	-0.00377 (0.00341)		
Constant	7.796*** (2.541)	6.807*** (1.107)	6.638*** (1.087)
Observations	17	17	17
R-square	0.221	0.821	0.827
Standard error in parenthesis			
*** p<0.01, ** p<0.05, * p<0.1			

### 4.3.2 Consumer Surplus

Figure 6 presents the annual consumer surplus per 100,000 residents for each zone. When the costs were estimated rather than reported by visitors, the consumer surplus was higher for visitors from Bethulia, El Zulia, Pamplona, Cúcuta, and Bucaramanga. These were the areas with the highest number of visitors. Since Bethulia has a small population, the visitor rate per unit of population was high. As expected, the consumer surplus was higher if the cost of time is taken into account. However, as previously discussed, there is controversy about the validity of placing an opportunity cost on leisure time and the specific method that was used in this study. The zone with the highest consumer surplus was Bogotá because of its larger population.

**Figure 6: Consumer Surplus Per 100,000 Residents by Zone**



The total consumer surplus from all zones ranged from 1,150 million and 2,169 million pesos per year (US 0.63 – 1.19 million) (Table 6). With a social discount rate of 12 percent, the consumer surplus value in perpetuity is between 9,592 million and 18,075 million pesos (US 5.24 – 9.88 million), according to the opportunity cost of time taken into account and assuming a number of zones and visitors by constant areas. However, these values in perpetuity are significantly higher with lower discount rates. As indicated in Table 7, the estimated recreation value is between 72,300 million and 38,333 million pesos (US 39.5 and 21 million) with a discount rate of 3 percent.

**Table 6: Total Annual Consumer Surplus—Estimated Recreation Value per Year**

Annual Consumer Surplus per Reported Cost		Annual Consumer Surplus per Total Cost		Annual Consumer Surplus per Travel Cost	
Million Pesos	US Million	Million Pesos	US Million	Million Pesos	US Million
<b>2,169</b>	1.19	1,363	0.75	1,150	0.63

**Table 7: Present Value in Perpetuity from Recreational Ecosystem Services**

Discount Rate	Annual Consumer Surplus per Reported Cost		Annual Consumer Surplus per Total Cost		Annual Consumer Surplus per Travel Cost	
	Million Pesos	US Million	Million Pesos	US Million	Million Pesos	US Million
<b>12%</b>	18,075	9.9	11,358	6.2	9,583	5.2
<b>7%</b>	30,986	16.9	19,471	10.6	16,429	9.0
<b>3%</b>	72,300	39.5	45,433	24.8	38,333	21.0

## 4.4. CONCLUSIONS

While the cost of travel is a widely used method for estimating the value of ecosystem services associated with recreation, it is important to recognize its limitations. First, it was not possible to capture all the visitors to the páramo because there are no records of visitors. The results of this small survey are likely to underestimate the total number of visitors. However, since the Páramo de Santurbán was not the main destination of the trip for 42 percent of the sample, the travel cost method would overestimate the consumer surplus associated with a large proportion of the trips.

Beyond the estimated monetary value, the survey found that people believed that the Páramo de Santurbán is valuable for ecotourism despite the difficulty in reaching the area and the current lack of tourist infrastructure. Additionally, the survey showed that visitors came not only from areas close to the páramo, but also from cities throughout Colombia and even from Caracas, Venezuela. This finding suggests that the area has considerable tourism potential.

Over 92 percent of the visitors agreed with expanding the protected area to cover the entire Páramo de Santurbán Regional Natural Park, even if it means that some activities will be restricted. Furthermore, 58 percent would agree to pay an entrance fee if it was a regional natural park. The average WTP among those who would agree to pay an entrance fee was 21,176 pesos per person.

This study can contribute to public decision making on the conservation of the Páramo de Santurbán by demonstrating that it provides recreation services that are valued by society despite the absence of a market.

It is important to highlight that this study estimates a lower bound economic value of the recreational services provided by the Páramo de Santurbán, which are likely to be even higher, as it is based on the travel cost method. This method assumes that economically rational visitors must place a value on the enjoyment of the site that is at least equal to the cost of the trip. The actual value placed on the visit may be much higher than the travel costs. The recreation value could be substantially higher with additional infrastructure that would make the visiting experience more enjoyable for all visitors.

# 5. CARBON SEQUESTRATION VALUE

## 5.1. INTRODUCTION

The cool temperature of the upland páramos results in very low rates of organic matter decomposition, which favor a slow, steady absorption of atmospheric CO<sub>2</sub>, primarily in the páramo's soils. In addition, páramo soils have a high water-retention capacity and are waterlogged for much of the year. The anaerobic conditions keep carbon fixed in the soil for longer periods of time. Taking into account that carbon sequestration and storage are a global ecosystem service, as they help to mitigate climate change, the study estimated the economic value of these services.

## 5.2. METHODOLOGY

A benefits transfer method was used to assess carbon sequestration in the Páramo de Santurbán. Benefits transfer is a technique used to value environmental goods and services based on secondary sources of information, preferably studies from a similar context. The estimated monetary value of an environmental asset from the study site is applied or adapted to the intervention site (Brouwer, 2000). This approach is used when primary data for the study site are not available or would be costly or time consuming to obtain. A benefits transfer study can provide approximate values when the need for precision is low (Brower, 2000; Navrud and Bergland, 2001; Rosenberg and Loomis, 2003; Osorio and Correa, 2004).

For example, the benefits of reducing phosphate pollution in river X can be estimated from a study of river Y with adjustments for differences in the local environments, and number and characteristics of consumers and producers.

There are two approaches to this method: transfer of values and transfer of functions. The transfer of values approach uses costs and benefits from a single study or summary statistics (such as averages) from a set of studies. The transfer of functions approach applies mathematical relationships estimated in other studies to the intervention site, inputting local data where possible. For valuation of extra-market goods and services, WTP is often the dependent variable, and the characteristics of environmental goods are the independent variables.

The main advantage of the transfer of benefits method is the low cost and ability to produce estimates quickly. This is an important advantage where funds, time, or staff preclude primary data collection. The main disadvantages are the difficulty finding area studies that are sufficiently similar and the risk that previous studies were not high quality and potentially reflected different relationships.

The estimates from a benefit transfer can be used as first approximations for preliminary decisions. They can be updated later as additional data and analyses are completed for the intervention site.

## 5.3. RESULTS

The carbon sequestration services of the Páramo de Santurbán were estimated for the entire 80,000 ha area. Of the studies on the carbon sequestered by Andean páramos, three were identified.

Hofstede (1999) concluded that páramos in Peru can accumulate more carbon than the rain forests, despite the difference in carbon stored in biomass. Whereas tropical ecosystems store the majority of carbon in its biomass, páramos store its vast majority in its soils. For example, Suárez (undated) summarizes the results of studies in páramos in Ecuador that indicate that soils store between 90 percent and 95 percent of the carbon stored in each ha. Rondón *et al.* (2002) found that the Páramo de las Ánimas in El Cauca, Colombia had 20 to 30 percent carbon content in the top layers of soil, decreasing gradually to 3 to 5 percent at one meter of depth.

García Portilla (2003) studied the carbon content in the soils of the Páramo de Chingaza, Colombia, distinguishing between mineral soil, mulch or top soil, and free organic matter. He found that the soils of the Páramo de Chingaza contained 10 percent carbon and 70 percent water, with no significant differences in the carbon content of mineral soil, mulch or top soil, and free organic matter. The soil carbon content was similar in the wet and dry slopes. This páramo held an average of 79.8 tons of CO<sub>2</sub> in the soil per hectare.

García Portilla's result is significantly lower than those found in other studies, such as Zúñiga-Escobar *et al.* (2013), who also estimated the amount of carbon stored in the soils of the Chingaza páramo in Colombia. According to their studies, undisturbed soils in the Chingaza páramo stored 520 tons of CO<sub>2</sub> per ha, compared with 131 tons of CO<sub>2</sub> per ha in disturbed páramo soils. IAVH (2008) estimates that 65 percent of the páramo's 82,600 ha are undisturbed, and the remaining 35 percent has been disturbed by agriculture, grazing, and mining activities.

The AILEG study used García Portilla's estimate that each ha of protected páramo prevents the emission of 79.8 tons of CO<sub>2</sub>, as a minimum level. Protecting 82,600 ha of the Páramo de Santurbán would avoid the emission of 6.6 million tons of CO<sub>2</sub> currently stored in the soil. In addition, it estimated a maximum value taking into consideration Zúñiga-Escobar's calculations. He estimated that preserving the 53,690 undisturbed ha of the páramo would prevent the emission of 389 tons of CO<sub>2</sub> per hectare, which totals to 20.9 million tons of CO<sub>2</sub>.

At a price of US \$37 per ton of carbon, the conservation of the páramo for its carbon content gives a value of US \$243.9 million or 446,062 million pesos, as a minimum, and US \$ 772.7 million, or 1,413,370 million pesos as a maximum value.<sup>14</sup>

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<sup>14</sup> This is the price per ton of carbon recommended by the United States Government: <http://www.whitehouse.gov/blog/2013/11/01/refining-estimates-social-cost-carbon>.

## 5.4. CONCLUSIONS

The conservation of the Páramo de Santurbán ensures the storage of a significant amount of CO<sub>2</sub>. If this ecosystem is degraded, the carbon stored in its soil and biomass would be released into the atmosphere.

The Government of Colombia should consider possible financing mechanisms for conservation of the páramo ecosystem through a clean development mechanism (CDM) or other payment scheme. This would require a more detailed study on the areas and quantities of CO<sub>2</sub> stored in the Páramo de Santurbán.

# 6. EXISTENCE AND BEQUEST VALUES

## 6.1. THEORETICAL FRAMEWORK

In addition to the economic value of using environmental services, such as maintenance of water quantity and quality or recreation, there are benefits to people who are not currently using the resources. The environmental economics literature discusses three types of non-use benefits: option value, existence value, and bequest value.

Option values are derived from forgoing the use of ecosystem goods and services at the current moment to preserve the option for future use by oneself or others. A quasi-option value reflects the net benefit of postponing a decision to use a resource while more information is collected (Arrow and Fisher 1974).

According to Krutilla (1967), people value environmental resources even if they never get to use them. He used the term existence value to reflect people's interest in conservation of natural resources even if they have never visited and have no plans to visit. People feel better off simply knowing that these natural areas remain in their country or elsewhere in the world.

Krutilla (1967) also developed the term bequest value to reflect the desire of people to preserve the natural resource for their descendants or, more broadly, future generations to use. People are willing to pay to protect the bequest values or may be willing to accept compensation (WTA) for their loss.

The AILEG team used the double-limit method to estimate the willingness of individuals who do not use the services provided by the Páramo de Santurbán to pay for the non-use values that they place on the ecosystem. This method was selected based on a literature review that found that in particular contexts, some methods are thought to perform better than others both conceptually and in practice.<sup>15</sup>

The double limit method follows an auction-like process (see Figure 7). First, respondents are asked if they would be willing to pay a particular sum of money for the conservation of the Páramo de Santurbán. Respondents who answered affirmatively are then asked if they would be willing to pay a specific considerably higher amount (e.g., twice the amount). If so, questions are asked about successively higher prices until a ceiling value is reached.

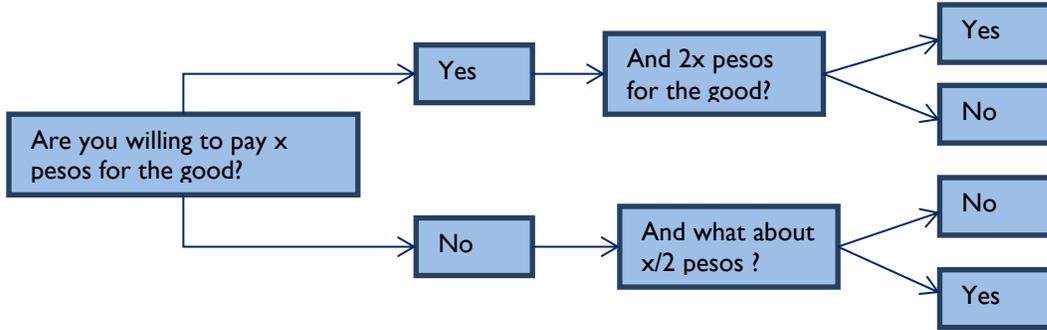
If the respondent answered negatively on the initial price, the next question would ask if they would be willing to pay a specific substantially lower amount to preserve the páramo (e.g., half the

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<sup>15</sup> Adamowicz et al. (1995); Shechter et al. (1998); and Carso, R. and Hanemann, W. M. (2005); among others.

price). Depending on the response, they would then be asked if they would pay a specific higher or lower price than that.

**Figure 7: Design of the Auction-Type Question**



Source: Carso and Hanemann, 2005

The double limit approach tends to reduce the frequency of “I do not know” answers; but, this does not necessarily make the results more valid. Many studies have found that the results are particularly sensitive to the level of the initial price and also sensitive to the subsequent prices used in the questions. The prices suggested by the interviewer may give information to the respondents about what level of prices they are expected to provide or the value that others have placed on the resource. This has been called anchoring bias and it is a type of instrumental bias. To reduce the effect of this problem on the aggregated results, it is advisable to use several levels of the initial price and subsequent price increments and it is best if this is done randomly. The AILEG survey used four different starting prices in the initial WTP question.

Respondents at all education levels typically have difficulty giving separate prices for existence bequest and option values. The AILEG study combined existence and bequest value in all of the questions and did not mention option value.

The data were used to develop a response probability model. With two valuation questions, there were four possible outcomes, as shown below. A was the initial amount of money in the initial question. C was the amount the person was willing to pay for the non-use values of the páramo. If the initial response was positive, the second question included a higher value, A1. Otherwise, a lower amount A2 was used. Replacing it in the general formula for the probability of multiple responses is shown below:

$$Q(\text{Answer yes/no}) = \Pr(A_1 \geq C \geq A) \equiv G_c(A_1) - G_c(A) \quad (1)$$

$$Q(\text{Answer no/yes}) = \Pr(A \geq C \geq A_2) \equiv G_c(A) - G_c(A_2) \quad (2)$$

$$Q(\text{Answer yes/yes}) = \Pr(C \geq A_1) \equiv 1 - G_c(A_1) \quad (3)$$

$$Q(\text{Answer no/no}) = \Pr(A_2 \geq C) \equiv G_c(A_2) \quad (4)$$

$G_c(x)$  is the cumulative distribution function of the willingness to pay. For a given individual,  $G_c(x)$  specifies the probability that his or her willingness to pay for the resource in question is less than  $x$  ( $\Pr(C \leq x)$ ).

This study applied two different econometric models commonly used in contingent valuation -- the bivariate probit model and the generalized linear model (GLM). The bivariate probit model focused on what determines that a person is willing to pay. The generalized linear model analyzed the amount that each respondent was willing to pay and extended the results to the target population.

### 6.1.1 Bivariate Probit Model

The bivariate probit model attempts to determine the probability that an individual with specific characteristics was willing to pay for the Páramo de Santurbán to become a regional natural park or not. Because of the survey design, the starting value was correlated with the amount in the next question. As a result, a bivariate probit model had to be used instead of a simple probit model. The bivariate probit model estimates the joint probabilities of the occurrence of accepting or rejecting the proposed second payment if the initial payment was accepted or rejected.

The probability that respondents were willing to pay for establishing a regional natural park may vary with their age, sex, education, income, etc., which determine the density function of the model. The bivariate probit uses a normal bivariate distribution function, represented by:

$$Q_i = P(y_1, y_2) = \frac{1}{\sqrt{2\pi(1-\rho)}} e^{[-\frac{1}{2(1-\rho^2)}(y_1^2 - 2\rho y_1 y_2 + y_2^2)]} \quad (5)$$

Where:

$y_1 = 1$  if the individual is willing to pay the initial amount and 0 otherwise

$y_2 = 1$  if the individual is willing to pay the amount proposed in the second phase and 0 if not

$\rho$  = the correlation among error differences

Two specifications for the bivariate probit model were used based Hanneman and Kanninen (1996). In both cases, the objective was to find the probability that the respondent would state a willingness to pay, depending on the initial amount requested:

$$\text{Model I: } \alpha - \beta \text{ payment} + \eta \quad (6)$$

$$\text{Model II: } \alpha - \beta \log(\text{payment}) + \eta \quad (7)$$

The payment variable is a dummy variable that takes the values of 1 if the respondent agreed to pay the initial sum and 0 if the respondent was unwilling.

The WTP was determined by applying Hanemann's model (1984). This model can either use the mean WTP ( $C^*$ ), or the median ( $C^+$ ):

$$\text{Model I: } C^* = C^+ = \alpha/\beta \quad (8)$$

$$\text{Model II: } \begin{cases} C^* = (e)^{\alpha/\beta} E \left\{ (e)^{\frac{\eta}{\beta}} \right\} \\ C^+ = (e)^{\alpha/\beta} \end{cases} \quad (9)$$

Where:

$$E \left\{ (e)^{\frac{\eta}{\beta}} \right\} = (e)^{\frac{1}{2}\beta^2} \text{ if the model is a probit}$$

$\alpha, \gamma$ , and  $\beta$  are the coefficients estimated in the initial model

Subsequently, the explanatory variables were selected based on the t-student criteria, e percentage of correct predictions, and the Chi-squared goodness of fit.

Since the probit model is non-linear, the parameters that accompany each explanatory variable cannot be interpreted as the variation of probability with a change in this variable. To properly interpret these coefficients, it is necessary to calculate the marginal effects.

### 6.1.2 Generalized Linear Model (GLM)

A generalized linear model is an extension of a linear model that uses non-normal distributions of errors and non-constant variances. A GLM uses a link function that defines the relationship between the systematic (non-random) or linear predictor and the dependent variable. Under a GLM, the dependent variable is generated from an exponential distribution function.

A GLM allows calculation of better estimates when the independent variables (income, age, and education) are correlated with the error term. Moreover, a GLM can narrow predictions through the link function if the data are greater than or equal to zero. In this case, we were trying to estimate how many people from Medellín and Bogotá would be willing to pay to preserve the páramo, and there were no negative numbers in the data. Several kinds of link functions can be used (identity, log, logit, reciprocal, square root, and exponential). Since the data are continuous and the errors had a normal distribution, we can assume that the domain and targets are the same, and used the identity function, which is a function that does not change the domain values at all.

## 6.2. METHODS

The survey included 404 respondents, but the data were only used for the 395 respondents who had previously visited the Páramo de Santurbán. Surveys were conducted in Cundinamarca and Antioquia, which are distant from the páramo and do not benefit directly from the páramo's water supply services.<sup>16</sup> Respondents were randomly selected in several shopping malls in the two cities. The survey asked about the non-use values that the respondents placed on the páramo and their

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<sup>16</sup> In Cundinamarca surveys were passed only in Bogotá, while in Antioquia, Medellín, Bello, La Ceja, Envigado, Itagüí, Girardota, Caldas, Copacabana, La Estrella, Rionegro, and Sabaneta were included.

demographic, socio-economic, and intrapersonal characteristics, along with their knowledge, appreciation, and attitudes about the environment in general and the páramos in particular.

### 6.2.1 Model Estimates

Before calculating the model estimates, the researchers considered how to handle the 33 percent of respondents who reported zero WTP because they believed that the government should bear the costs of preserving the páramo, not individuals. According to Carson (1991), contingent valuation methods often elicit protest votes by 20-30 percent of the respondents. Since these zero responses did not imply that the respondents considered the páramo to have no value, the team treated these observations as missing data, rather than zero values. The study also assessed the effects of imputing a specific non-zero value to protest votes, but the estimates obtained under these specifications did not provide any significant results.

Initially, the estimated function included all of the independent variables obtained from the survey:

Age (years)

Sex: 1=male, 2=female

Highest educational level reached

Individual income (monthly)

Socio-economic level: according to water bill (1 to 6, where 6 is the highest)<sup>17</sup>

Environmental concern index based on the following factors:

- General concern for the environment
- Frequency in which the person separates trash
- Frequency of turning off the faucet while brushing teeth
- Use of energy-efficient light bulbs
- Frequency of showering longer than five minutes

Three initial models were then estimated.

#### Model 1 (Bivariate Probit)

First stage (same for models 1 and 2):

$$payment = \alpha_0 + \alpha_2 * age + \alpha_3 * sex + \alpha_4 * educ + \alpha_5 * income + \alpha_6 * level + \alpha_7 * concern + \varepsilon_1 \quad (12)$$

Second stage:

$$payment2 = \beta_0 + \beta_1 * price1 + \beta_2 * age + \beta_3 * sex + \beta_4 * educ + \beta_5 * income + \beta_6 * level + \beta_7 * concern + \varepsilon_2 \quad (13)$$

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<sup>17</sup> In Colombia, each municipality must classify residential real estate into different levels (*estratos*), based on which different rates are charged for public services, enabling cross-subsidies between groups with higher and lower economic capacity. Levels are not based on income, but on the real estate's characteristics and location.

## Model 2 (Bivariate Probit)

First stage (see model 1):

Second stage:

$$\text{payment2} = \beta_0 + \beta_1 * \log(\text{precio1}) + \beta_2 * \text{age} + \beta_3 * \text{sex} + \beta_4 * \text{educ} + \beta_5 * \text{income} + \beta_6 * \text{level} + \beta_7 * \text{concern} + \varepsilon_2 \quad (14)$$

## Model 3 (GLM)

$$\text{WTP} = \alpha_0 + \alpha_2 * \text{age} + \alpha_3 * \text{sex} + \alpha_4 * \text{educ} + \alpha_5 * \text{income} + \alpha_6 * \text{level} + \alpha_7 * \text{concern} + \varepsilon_1 \quad (15)$$

The results showed that willingness to pay the initial amount requested depended on income, gender, and the environmental concern of the respondent. The answer to the second question was affected by the initial price (phase I), income, and level of concern for the environment. The only factor that negatively affected the probability of contributing to the conservation of the páramo was the initial price.

## 6.3. RESULTS

Bivariate probit model coefficients have no economic interpretation. Instead, Table 8 shows the marginal effects obtained from the two bivariate models to determine how much the WTP is affected by the characteristics of individuals. Under Model 1, the probability of a non-zero willingness to pay increased by 2.9 percent as income rises to the next upper range (see Annex 10.5 for more details on income ranges and other statistics relevant for existence and bequest values). Female respondents were 3 percent more likely to be willing to pay for páramo conservation, other things being equal. As respondents score on the environmental concern index increased, the probability of being willing to pay for páramo conservation went up 2 percent, other things being equal (Annex 10.6 explains how the index was estimated). The marginal effects under Model 2 were not very different from those in Model 1, as can be observed from the results in Table 8.

**Table 8: Marginal Effects of the Probit Model**

	Bivariate Probit	
	(1)	(2)
	P (payment=1, payment 2=1)	
Price I		-3.88e-06***
	(1.36e-06)	
Natural log of price I		-0.088***
		(0.0289)
Income	0.0296**	0.00299**
	(0.0117)	(0.0117)
Female	0.032**	0.033**
	(0.016)	(0.016)
Concern	0.020***	0.020***
	(0.0072)	(0.0072)

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Changes in the initial price had a large effect on the final willingness to pay, which represents a type of instrumental bias. The initial starting price was 10,000 pesos. The incremental WTP increased by 11,634 pesos at a starting price of 20,000 pesos, 20,211 pesos at a starting price of 30,000 pesos, and 24,825 pesos at a starting price of 40,000 pesos. A higher level of education increased the willingness to pay by 2,557 pesos, other things being equal. A one-unit increase in the index of environmental concern was associated with a 1,113 pesos increase in the WTP, other things being equal (Table 9). This estimate also included gender and social level, but they did not have significant effects on this model.

**Table 9: Final Estimates of the Generalized Linear Model on Amount that each Respondent was Willing to Pay**

	<b>Generalized Linear Model</b>
Dependent variable: willingness to pay	(3)
Education	2,557** (1,162)
Concern for the environment	1,113*** (430.29)
Income	1,403** (654.33)
Initial price 10,000 pesos	0 (0)
Initial price 20,000 pesos	11,634*** (1,973)
Initial price 30,000 pesos	20,211*** (3,172)
Initial price 40,000 pesos	24,825*** (3,275)
Constant	-8,237 (5,328)
R squared	0.273
Log likelihood	-3240.59
Observations	287

Standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The willingness to pay under the bivariate probit model was estimated using the Hanemann (1984) method from the models specified in (6) and (7). For the GLM, the mean and median predicted by the selected model were used. Table 9 presents the results obtained with each model. It can be observed that the willingness to pay once for converting the Páramo de Santurbán into a regional natural park varies between 31,335 and 102,172 pesos (US \$17 and \$56).

**Table 10: Average, Medians and Range of Estimated Willingness to Pay For Non-Use Values Under the Bivariate Probit and Generalized Linear Models (in Pesos)**

Model	Bivariate Probit				Generalized Linear Model
	Model I		Model II		
	WTP	Range	WTP	Range	
Average	34,760	30,310–41,839	102,172	54,361–761,660	Willingness to Pay (WTP) 31.335
Median			34,671	28,313–47,868	32.468

The samples taken for Medellín and Bogotá were estimated to be representative of the cities' population based on the methods used to select them, allowing the study to estimate the aggregated willingness to pay for these two cities. Using the large Integrated Household Survey (LEIH, 2011), the minimum aggregate WTP to convert the Páramo de Santurbán into a regional natural park was estimated at 238 billion pesos (US \$130 million). The maximum WTP was 777

billion pesos (US \$425 million) (Table I I). Since these two cities are not representative of the nation as a whole, the national non-use value was not estimated.

**Table I I: Aggregate Willingness to Pay for Non-Use Values in Medellín and Bogotá**

	Frequency		Willingness to Pay (WTP)	Total
	(Persons)		(Pesos)	(Million Pesos)
	Medellín	Bogotá		
Minimum WTP	2,447,348	5,154,948	31,335	238,217.95
Maximum WTP	2,447,348	5,154,948	102,172	776,741.79

Source: GEIH 2011

## 6.4. CONCLUSIONS

The contingent valuation method showed its limitations. There was a large correlation between the WTP and the initial price used in the survey. The hypothetical nature of the questions and the likelihood of instrumental bias and strategic bias undoubtedly affected the results.

Besides the limitations of this methodology, results could also be under- or over-estimated due to a bias in the way the question on WTP was asked. According to Carson (1991), contingent valuation methods often elicit protest votes by 20-30 percent of the respondents, but they only reached 12 percent in our sample.

Nevertheless, the study found that respondents in Bogotá and Medellín who did not directly benefit from use of the Páramo de Santurbán expressed an average willing to pay of 30,310 pesos (US \$16.60) to convert the páramo into a regional natural park. The willingness to pay increased substantially with educational level, income range, and an environmental concern index. Women respondents expressed a slightly higher WTP than men. These findings may be useful in targeting potential, voluntary contributors of money for conservation of páramos and other natural ecosystems.

## 7. CONCLUSIONS AND POLICY RECOMMENDATIONS

The previous chapters of this report have estimated the economic value of various environmental services provided by the Páramo de Santurbán. Since these economic values estimated in the previous chapters for various use and non-use benefits are not mutually exclusive, they can be added up into a total economic value (TEV). A lower bound estimate of the TEV of the Páramo de Santurbán was calculated. At a real discount rate of 12 percent, the minimum TEV was 821,041 million pesos (US \$449 million) and the maximum was 2,981,742 million pesos (US \$1.63 billion); the TEV increased substantially if other discount rates were used, as indicated in f WTP for the services valued.

Table 12.

The lower estimates of WTP for the various services were used to calculate the minimum TEV. In the case of carbon sequestration, the maximum and minimum values were calculated based on the different amount of carbon stored in páramo's soils, reported in the literature for Colombia. The maximum TEV scenario was based on the higher estimate of WTP for the services valued.

**Table 12: Total Economic Value of the Páramo de Santurbán**

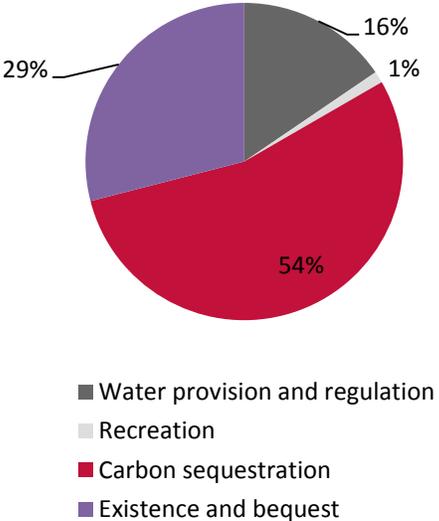
Service	Discount Rate	Minimum Value	Maximum Value	Minimum Value	Maximum Value
		(Million pesos)		(US Million)	
Water provision and regulation	12%	127,166	733,547	70	401
	7%	217,999	1,257,509	119	688
	3%	508,663	2,934,189	278	1,604
Recreation	12%	9,592	18,075	5	10
	7%	16,429	30,986	9	17
	3%	38,333	72,300	21	40
Carbon sequestration	n.a.	446,065	1,413,378	244	773
Existence and bequest	n.a.	238,218	776,742	130	425
<b>Total Economic Value</b>	12%	821,041	2,981,742	449	1,630
	7%	918,711	3,478,615	502	1,902
	3%	1,231,279	5,196,609	673	2,841

The contribution of each service to the páramo's TEV varies significantly depending on the used discount rate and on the differences between minimum and maximum values (see figures 8 - 13). The values from water provision and regulation, as well as from recreation, could provide a flow of income into the future. As discussed earlier, this study used different discount rates to estimate the present value of those streams of income, recognizing that lower discount rates give more

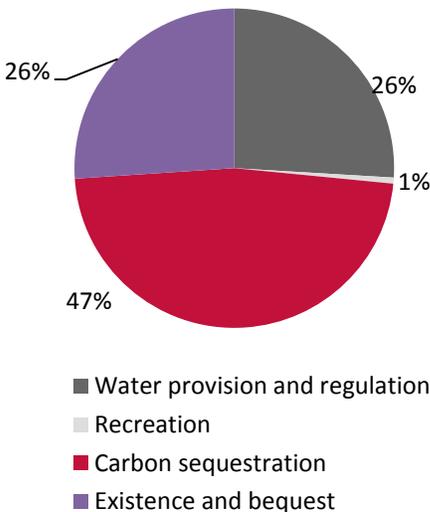
value to future consumption than higher discount rates, which comparatively value more present consumption. Generally speaking, all values increase when a lower social discount rate is used.

In the case of carbon sequestration and existence and bequest values, they constitute a one time payment. These values are the same in all the scenarios; however, their relative contribution to TEV falls when the values of other services increase as a result of the use of a lower discount rate. Carbon sequestration contributes with between 27 percent and 54 percent of TEV, water provision and regulation with between 16 percent and 57 percent, existence and bequest, between 15 percent and 29 percent, and recreation with between 1 percent and 3 percent of TEV.

**Figure 8: Contribution of Each Ecosystem Service to TEV (Minimum Values, 12% Discount Rate)**

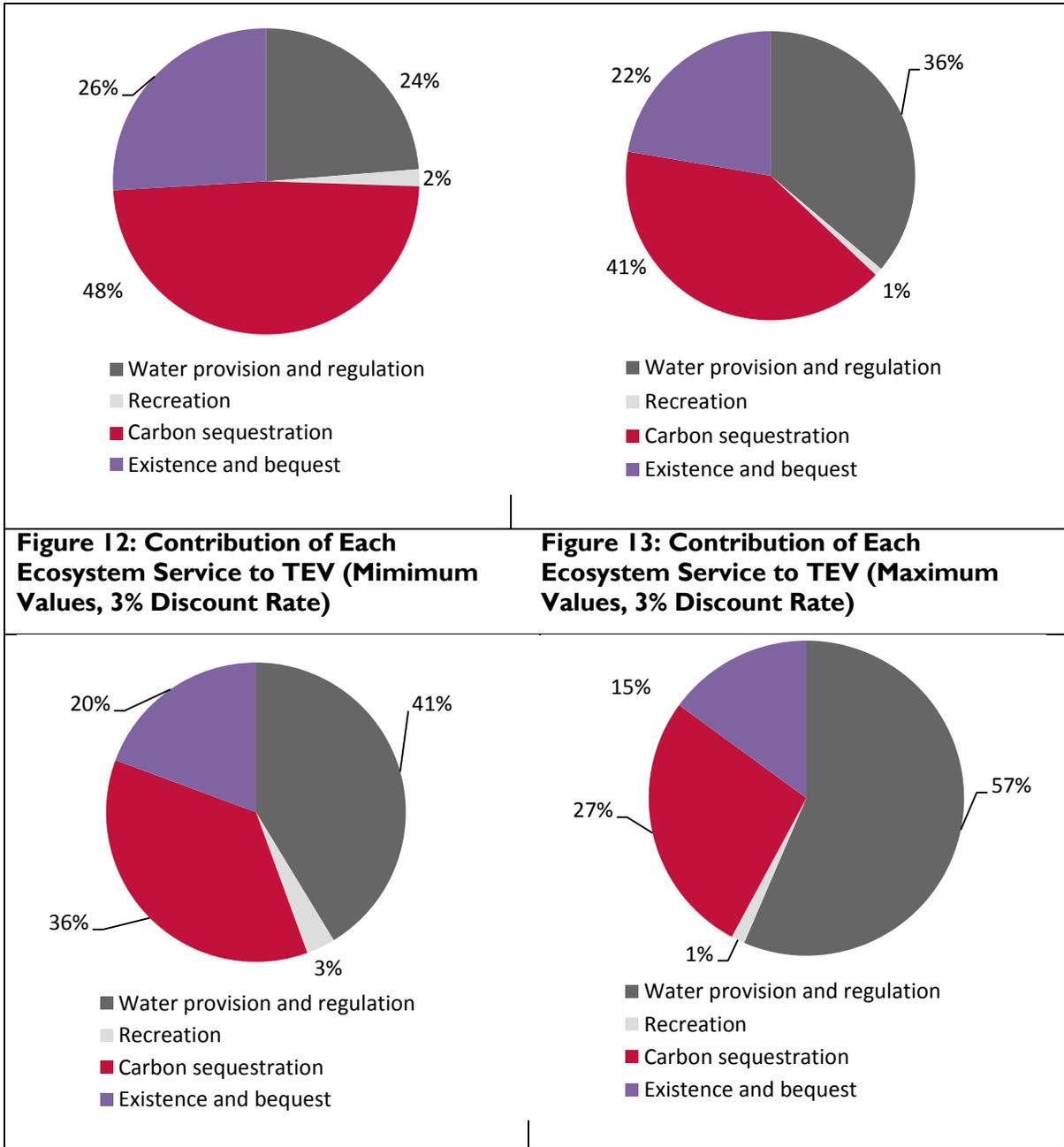


**Figure 9: Contribution of Each Ecosystem Service to TEV (Maximum Values, 12% Discount Rate)**



**Figure 10: Contribution of Each Ecosystem Service to TEV (Minimum Values, 7% Discount Rate)**

**Figure 11: Contribution of Each Ecosystem Service to TEV (Maximum Values, 7% Discount Rate)**



This preliminary assessment of the economic value of the ecosystem services of the Páramo de Santurbán addressed water provision and regulation for residential consumers, recreational use value, carbon sequestration, and existence and bequest values. Each of these values was estimated using what was considered the best available method, based on the economic literature and the availability of data. It should be emphasized that these values represent a lower bound estimate that excluded water supply for agriculture and other economic activities, and biodiversity. Furthermore, the value was constrained by the usual limitations of the extra-market economic valuation methods used and available data.

Nevertheless, the results can serve as input for public policies for conservation of the Páramo de Santurbán. The study found substantial WTP for water provision and regulation services by

residents of the nearby towns. The minimum increase in the water bill that water users would be willing to pay in the bimonthly bill of the cities of Bucaramanga, Cúcuta, and Pamplona was estimated at 3,000 pesos. If a mechanism was established to collect this amount, it could generate 7,393 million pesos (US \$4 million) annually for the páramo's conservation. With these resources, a payment for environmental services (PES) system could be established to compensate páramo landowners for conservation of areas outside the declared regional natural park. Other studies have shown that a PES scheme is most successful when there is a direct relationship between the provider and the environmental service user as compared to when the government buys the land or pays the owners from the national budget. The fact that users themselves pay for conserving the resource makes the scheme more sustainable because it does not depend directly on the political will of the officials on duty or on the government's budget availability.

As is often the case, the contingent value method elicited a substantial proportion of the protest votes that do not imply that respondents felt the resource had no value. They reflected a stand against being asked to pay for something they feel the government should fund. It would be useful to establish a dialogue between the government and the public to build on this finding. In addition, a future contingent valuation survey could be conducted to identify the maximum amount that people think the government should pay to conserve the ecosystem and views on different ways that the government could obtain the money for this.

This study also found that information and education on the páramos can have a positive effect on individuals' willingness to pay. This suggests that information and awareness campaigns could promote conservation.

The Páramo de Santurbán is an area with a high potential to attract tourists. Despite the current lack of visitor facilities (clear routes of access, services, lodging, and food), a significant number of visitors come to the area. Over 92 percent of the visitors interviewed would like to see the area designated a regional natural park and 58 percent would be willing to pay an entrance fee of about 21,000 pesos (US \$11.50). Developing the potential for low-impact tourism could help support the sustainable management of the ecosystem.

There are small, existing markets for carbon sequestration. However, a more-detailed study would be needed to identify the amount of CO<sub>2</sub> captured in the soil of the Páramo de Santurbán and estimate the amount of CO<sub>2</sub> that would be emitted under the current conservation incentive.

Another important finding is that funding for conservation activities does not have to come from people living in the region. Residents of other regions were also willing to pay for the conservation of the Páramo de Santurbán even if they had no plans to visit the area. Information and environmental education can also have a significant effect on the willingness to pay of non-users.

There are several possible solutions to the conflict between gold mining and the maintenance of water quantity and quality from the páramo. One option would be to prohibit gold mining in the area. This option is more likely to be effective if equally profitable alternative economic activities can be identified for people currently engaged in legal mining activities. Training, employment placement, and financing of alternative investments could be supported through funding from users of the páramo's services. These incentives would need to be combined with effective enforcement of mining restrictions. Since extreme solutions may be difficult to sustain over time, it may be best to reach a compromise.

A second alternative for reducing the contamination of water sources by mining would be to allow mining, but require ore processing to be done outside of the páramo in areas less susceptible to water pollution and geologic instability. The additional costs would be borne by private companies.

A third alternative would be to require the construction of a treatment plant in the area to remove pollutants generated by mining (mainly mercury and cyanide) so that effluents are within the established standards. The costs of the treatment plant could be borne by private companies.

The most appropriate alternatives will depend on the legal and regulatory environment, property rights, and transaction costs.

Additional research is also needed on the ecosystem's characteristics, environmental risks, and the services it provides to reach better conservation and development solutions.

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## 9. ANNEXES

### 9.1. WATER USERS' SURVEY

A total of 712 surveys were conducted in the cities of Bucaramanga, Cúcuta, and Pamplona. They were collected from a simple random sampling by neighborhood and social level in each of the three cities. In turn, the study used polling firms who had developed fieldwork in these districts to streamline processes and facilitate access to neighborhoods with security issues.

Results: The vast majority of respondents (99.3 percent) were Colombians. In terms of residence, 29.9 percent of them lived in Bucaramanga; 37.5 percent in Cúcuta; and 14.4 percent in Pamplona. In terms of gender, 56.7 percent were women and 43.3 percent were men, with ages ranging between 17 and 85 years. The average age was 39 years (with a significance level of 99 percent), with 69.1 percent living in homes classified as social levels two and three (30.5 percent and 38.6 percent, respectively).

About 61.24 percent of respondents receive a monthly salary of less than or equal to 600,000 pesos (US \$328). Regarding schooling levels, most respondents were at the secondary level (48.2 percent), followed by the primary level (19.2 percent), and technical level (14.5 percent). Table 13 summarizes the general information obtained from the water users' survey.

**Table 13: Description of the sample by occupation, social level, education level and income range (Percent)**

Occupation	Percent (%)	Social Level	Percent (%)	Education Level	Percent (%)	Income Range (Pesos)	Percent (%)
Employed	28.93	1	15.73	Primary	19.24	0 to 600,000	61.24
Unemployed	3.65	2	30.48	Secondary	48.17	600,001 to 1,000,000	19.10
Independent	41.29	3	38.62	Technical	14.47	1,000,001 to 1,500,000	7.16
House chores	15.73	4	13.62	Professional	14.04	1,500,001 to 2,000,000	2.25
Student	16.15	5	0.28	Post-graduate	1.26	2,000,001 to 2,500,000	1.12
Other	3.23	6	0.00	None	2.39	2,500,001 to 3,500,000	0.70
Retired	1.83	NR*	1.26	NR*	0.42	3,500,001 to 5,000,000	0.14
						NS/NR	8.29

\* No response/Do not know

Results from questions about the valuation of the páramo, as well as the WTP for water, were statistically significant at 99 percent. The majority stated they were not WTP for the páramo to be declared a regional natural park. They accounted for 67.4 percent of the sample (480

respondents). Among these, 63 percent said the government should bear the cost, and 29 percent said they were not able to make the payment. The remaining 32.6 percent of respondents (232 respondents) agreed to pay an average of 46,043 pesos (US \$25), with a significance level of 99 percent, and a standard deviation of about 95,000 pesos. The minimum value was close to the average and the maximum value was 1 million pesos.

Finally, survey respondents were asked if they would be willing to pay an entrance fee in the hypothetical case that it were declared a regional natural park. Close to 60 percent of the respondents accepted to make a payment, which averaged to 8,000 pesos (US \$4.3). Results had a significance level of 99 percent and a standard deviation of 8,200 pesos.

The following questions were also asked as part of the survey:

- Do you know where the water that you use in your home comes from?*
- Do you know what a páramo is?*
- Have you heard of the Páramo de Santurbán?*
- Do you know what environmental services are offered by the páramos?*
- Have you heard about the gold mining extraction projects at the Páramo de Santurbán?*

Answers about the origin of the water used at home revealed that 68.1 percent of the sample reported knowing the answer, while 31.3 percent said they did not know. Answers about the definition of a páramo revealed that 82.7 percent of people answered affirmatively, of which 65 percent also knew about the Páramo de Santurbán (see Table 14).

**Table 14: Question on general knowledge about the Páramo de Santurbán and páramos in general**

		Have you heard about the Páramo de Santurbán?			Total
		Yes	No	No response/ Do not know	
Do you know what a páramo is?	YES	462	116	11	589
	NO	50	73	0	123
<b>Total</b>		<b>512</b>	<b>189</b>	<b>11</b>	<b>712</b>

Results about the environmental services the páramos offer, 51.4 percent said they had knowledge about them, while 27.7 percent reported not knowing. Finally, it is important to note that for the question on knowledge about the gold mining projects in the páramo, 77.7 percent answered affirmatively—a proportion that is similar to those who knew what the Páramo de Santurbán is.

Upon disaggregating knowledge questions by department—Santander and Norte de Santander—the most notable difference is that the respondents from Norte de Santander have a

proportionally greater understanding of the páramos than respondents in Santander. However, when it comes to the questions associated with Páramo de Santurbán, the opposite is true (see Table 15).

**Table 15: Questions on knowledge about the páramos**

Departme nt	Do you know where the water you use at home comes from?		Do you know what a páramo is?		Do you know about the environmental services provided by the páramos?		Have you heard about the Páramo de Santurbán?		Have you heard about the gold extraction mining projects in Páramo de Santurbán?	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
<b>NORTE DE SANTANDER</b>										
Yes	284	71.4%	347	87.2%	205	51.5%	259	65.1%	245	61.6%
No	113	28.4%	51	12.8%	135	33.9%	133	33.4%	153	38.4%
Do not know/ no response	1	0.3%	0	0.0%	58	14.6%	6	1.5%	0	0.0%
Total	398	100.0%	398	100.0%	398	100.0%	398	100.0%	398	100.0%
<b>SANTANDER</b>										
Yes	201	64.0%	242	77.1%	161	51.3%	253	80.6%	266	84.7%
No	110	35.0%	72	22.9%	62	19.7%	56	17.8%	48	15.3%
Do not know/ no response	3	1.0%	0	0.0%	91	29.0%	5	1.6%	0	0.0%
Total	314	100.0%	314	100.0%	314	100.0%	314	100.0%	314	100.0%
<b>TOTAL</b>										
Yes	485	68.1%	589	82.7%	366	51.4%	512	71.9%	511	71.8%
No	223	31.3%	123	17.3%	197	27.7%	189	26.5%	201	28.2%
Do not know/ no response	4	0.6%	0	0.0%	149	20.9%	11	1.5%	0	0.0%
<b>TOTAL</b>	712	100.0%	712	100.0%	712	100.0%	712	100.0%	712	100.0%

Furthermore, regarding the questions on the environmental services provided by the páramos, the difference in favor of Norte de Santander is not significant (0.2 percent). For questions about knowledge of the mining projects in Páramo de Santurbán, the differences are more pronounced, with 15.5 percent and 23.2 percent respectively, in favor of Santander. Of the three questions about the páramos, the question asking if the respondent knows what a páramo is shows the greatest differences in favor of Norte de Santander (10.1 percent), since 87.2 percent stated having knowledge, while in Santander, 77.1 percent answered affirmatively.

The following tables disaggregate the information by city.

**Table 16: Do you know where the water you use at home comes from?**

	Yes		No		Do not know/No Response		TOTAL	
	No	%	No	%	No	%	No	%
Bucaramanga	172	81	38	18	3	1	213	100
Cúcuta	176	66	90	34	1	0	267	100
El Zulia	0	0	2	100	0	0	2	100
Florida Blanca	5	15	28	85	0	0	33	100
Giron	1	100	0	0	0	0	26	100
Los Patios	18	69	8	31	0	0	26	100
Pamplona	87	87	13	13	0	0	100	100
Piedecuesta	23	34	44	66	0	0	67	100
Villa del Rosario	3	100	0	0	0	0	3	100
<b>TOTAL</b>	<b>485</b>	<b>68</b>	<b>223</b>	<b>31</b>	<b>4</b>	<b>1</b>	<b>712</b>	<b>100</b>

**Table 17: Do you know what a páramo is?**

	Yes		No		Do not know/No Response		TOTAL	
	No	%	No	%	No	%	No	%
Bucaramanga	183	86	30	14	0	0	213	100
Cúcuta	225	84	42	16	0	0	267	100
El Zulia	1	50	1	50	0	0	2	100
Florida Blanca	19	58	14	42	0	0	33	100
Giron	1	100	0	0	0	0	1	100
Los Patios	25	96	1	4	0	0	26	100
Pamplona	93	93	7	7	0	0	100	100
Piedecuesta	39	58	28	42	0	0	67	100
Villa del Rosario	3	100	0	0	0	0	3	100
<b>TOTAL</b>	<b>589</b>	<b>83</b>	<b>123</b>	<b>17</b>	<b>0</b>	<b>0</b>	<b>712</b>	<b>100</b>

**Table 18: Do you know about the environmental services provided by páramos?**

	Yes		No		Do not know/No Response		TOTAL	
	No	%	No	%	No	%	No	%
Bucaramanga	137	64	32	15	44	21	213	100
Cúcuta	137	51	86	32	44	16	267	100
El Zulia	1	50	0	0	1	50	2	100
Florida Blanca	8	24	11	33	14	42	33	100
Giron	1	100	0	0	0	0	1	100
Los Patios	16	62	9	35	1	4	26	100
Pamplona	49	49	39	39	12	12	100	100
Piedecuesta	15	22	19	28	33	49	67	100
Villa del Rosario	2	67	1	33	0	0	3	100
<b>TOTAL</b>	<b>366</b>	<b>51</b>	<b>197</b>	<b>28</b>	<b>149</b>	<b>21</b>	<b>712</b>	<b>100</b>

**Table 19: Have you heard about the Páramo de Santurbán?**

	Yes		No		Do not know/No Response		TOTAL	
	No	%	No	%	No	%	No	%
Bucaramanga	184	86	24	11	5	2	213	100
Cúcuta	170	64	93	35	4	1	267	100
El Zulia	1	50	1	50	0	0	2	100
Florida Blanca	26	79	7	21	0	0	33	100
Giron	1	100	0	0	0	0	1	100
Los Patios	20	77	6	23	0	0	26	100
Pamplona	65	65	33	33	2	2	100	100
Piedecuesta	42	63	25	37	0	0	67	100
Villa del Rosario	3	100	0	0	0	0	3	100
<b>TOTAL</b>	<b>512</b>	<b>72</b>	<b>189</b>	<b>27</b>	<b>11</b>	<b>2</b>	<b>712</b>	<b>100</b>

**Table 20: Have you heard about the gold extraction mining projects in the Páramo de Santurbán?**

	Yes		No		Do not know/No Response		TOTAL	
	No	%	No	%	No	%	No	%
Bucaramanga	187	88	26	12	0	0	213	100
Cúcuta	159	60	108	40	0	0	267	100
El Zulia	1	50	1	50	0	0	2	100
Florida Blanca	29	88	4	12	0	0	33	100
Giron	1	100	0	0	0	0	1	100
Los Patios	19	73	7	27	0	0	26	100
Pamplona	63	63	37	37	0	0	100	100
Piedecuesta	49	73	18	27	0	0	67	100
Villa del Rosario	3	100	0	0	0	0	3	100
<b>TOTAL</b>	<b>511</b>	<b>72</b>	<b>201</b>	<b>28</b>	<b>0</b>	<b>0</b>	<b>712</b>	<b>100</b>

Regarding the question on awareness about the household's water source, the city that shows greater knowledge is Pamplona, with 87.0 percent; followed by Bucaramanga (80.8 percent), Cúcuta (65.9 percent), and Piedecuesta (34.3 percent). On the other hand, the city with the highest percentage of positive answers to the question about knowledge of what a páramo is was Pamplona (93.0 percent), followed by Bucaramanga (85.9 percent), Cúcuta (84.3 percent), and finally Piedecuesta (58.2 percent).

Regarding the question about environmental services, Bucaramanga scored the highest, where 64.3 percent of people reported knowing about them, followed by Cúcuta (51.3 percent), and then Pamplona (49.0 percent) and Piedecuesta (28.4 percent).

Concerning the question on knowledge of the Páramo de Santurbán, Bucaramanga had the highest level of affirmative responses (86.4 percent), while affirmative answers in Cúcuta, Pamplona, and Piedecuesta were around 60 percent (Pamplona at 65.0 percent, Cúcuta at 63.7 percent, and Piedecuesta at 62.7percent).

Finally, regarding the question on the knowledge of Páramo de Santurbán gold mining projects, Bucaramanga and Piedecuesta showed greater understanding at 87.8 percent and 73.1 percent, respectively, followed by Pamplona and Cucuta at 63 percent and 59.6 percent, respectively.

In conclusion, Pamplona and Bucaramanga have higher levels of knowledge compared to the other municipalities. In Cúcuta, although the majority of the population has knowledge about the páramos, the percentage is lower than in Pamplona and Bucaramanga. Pamplona has the highest proportion of people with knowledge about the source of their water and what a páramo is, while Bucaramanga has the highest proportion of people who know about the Páramo de Santurbán and mining projects.

In terms of perceptions, respondents were asked about the possibility for their town to have water supply problems in the future. In general, most respondents see it as a possibility. A total of 88 percent of respondents see it as somewhat likely or very likely, while 9 percent think it is somewhat or very unlikely (see Table 21).

**Table 21: How likely do you think it is for your municipality to have drinking water supply problems in the next twenty years?**

Options	Observations	Percentage
Very likely	333	46.8%
Likely	299	42.0%
Not very likely	54	7.6%
Not at all likely	13	1.8%
Do not know/No response	13	1.8%
<b>Total</b>	<b>712</b>	<b>100.0%</b>

Disaggregating the data by department, risk perceptions are lower in Santander than in Norte de Santander. In Santander, 84.4 percent believe the risk is likely or very likely, compared to 92.2 percent in North Santander. Table 22 breaks down the information by response and department.

**Table 22: Perception of future risk by department**

Options	Norte de Santander		Santander	
	Observations	Percentage	Observations	Percentage
Very Likely	196	49.3%	137	43.6%
Likely	171	43.0%	128	40.8%
Not very likely	19	4.8%	35	11.2%
Not at all likely	3	0.8%	10	3.2%
Do not know/No response	9	2.3%	4	1.3%
<b>Total</b>	<b>398</b>	<b>100.0%</b>	<b>314</b>	<b>100.0%</b>

In Bucaramanga, 97.2 percent of respondents believe it is likely or very likely to have water supply problems in the future. Pamplona and Cúcuta follow with 92.0 percent and Piedecuesta with 59.7 percent.

Regarding the valuation and attitude of respondents, the following questions were asked:

*In the last 24 months, have you travelled to a natural recreational site, natural reserve zone, national natural park, or carried out eco-tourism activities?*

*Do you agree that the Páramo de Santurbán be declared a National Natural Park?*

A question posed the dilemma between the benefits and risks of the mining project in the Páramo de Santurbán ecosystem and on the water resources of the Páramo de Santurbán.

The majority of the surveyed population (67.4 percent) had not visited any natural recreation site. Importantly, of the total number of questions on attitudes toward the environment, this one scored the lowest percentage of responses associated with a positive attitude towards the environment (see Table 23).

**Table 23: Have you visited a natural recreational site?**

Options	Observations	Percentage
Yes	232	32.6%
No	480	67.4%
<b>Total</b>	<b>712</b>	<b>100.0%</b>

Disaggregating the information per department, the most outstanding fact is the great difference in answers among respondents from Santander and Norte de Santander, since the former stated having traveled to a natural recreational site (54.8 percent yes; 45.2 percent said no), while 84.9 percent of the residents of Norte de Santander said they had not. This situation can be explained by the fact that Santander is recognized for its efforts to promote eco-tourism.

At the level of municipalities, the cities with the most eco-tourism are Bucaramanga (59.2 percent of surveyed citizens) and Piedecuesta (41.8 percent). In Cúcuta, only 19.1 percent responded positively, a situation that becomes more acute in Pamplona, where only 2.0 percent of answers are positive.

The second question asked whether the respondent would agree with the declaration of the Páramo de Santurbán as a regional natural park. A total of 86.5 percent of respondents said they agreed (see Table 24).

**Table 24: Would you agree with the declaration of Páramo de Santurbán as a Regional Natural Park?**

Options	Observations	Percent
Yes	616	86.5%
No	61	8.6%
Do not know/No response	35	4.9%
<b>Total</b>	<b>712</b>	<b>100.0%</b>

Table 25 and

Table 26 present the overall results for questions about the relationship between a potential gold mining project and its implications for the páramo ecosystem and water quality.

**Table 25: Do you think that these projects (mining):**

Options	Observations	Percent
a. Bring more benefits than risks to society and the páramo ecosystem?	21	2.9%
b. Bring more risks than benefits to society and the páramo ecosystem?	472	66.3%
c. Do not change the well-being of society and the environment, and do not cause damages to the páramo ecosystem?	11	1.5%
d. Do not know/No response	208	29.2%

**Table 26: Regarding the impact of these projects on the quality of water, do you believe that:**

Options	Observations	Percent
a. They put water quality of rivers, watersheds, and streams of Páramo de Santurbán at irreparable risk?	394	55.4%
b. They put water quality of rivers, watersheds, and streams of Páramo de Santurbán at moderate and reparable risk?	44	6.2%
c. They put water quality of rivers, watersheds and streams of Páramo de Santurbán at risk?	69	9.7%
d. Do not know/No response	205	28.8%

Interestingly, over 55 percent of respondents believe that mining brings risks to the páramo and the quality of its water. This percentage is more pronounced in the case of the páramo ecosystem, where 66.3 percent believe that mining brings more risks than benefits for society and the páramo ecosystem.

Regarding the impact of mining on water quality, it is noteworthy that the option chosen was *a* rather than *b*; the first being more radical than the second. A reported 55.3 percent of the sample respondents believed that mining poses an irreparable threat to water quality of rivers and streams of the Páramo de Santurbán.

Another element worth highlighting from aggregate information is the weight of the option *Do not know /no response*, which may have two explanations. There could be a group of people who do not want to take a risk by giving an opinion, given the sensitivity of the issue in the region, or it could stem from a misunderstanding of the question.

An analysis of the data by department shows a difference between the proportion of those who answered option *b*, since it is smaller compared to those who believe in the possibility of more risks than benefits in Santander (78 percent) and in Norte de Santander (57.0 percent) (see Table 27). This is due to the greater number of respondents who answered Do not know/No answer in the department of Norte de Santander (39.7 percent).

**Table 27: Do you believe that these mining projects (disaggregated by department):**

Options	Norte de Santander		Santander	
	Observations	Percentage	Observations	Percentage
a. Bring more benefits than risks to society and the páramo ecosystem?	7	1.8%	14	4.5%
b. Bring more risks than benefits to society and the páramo ecosystem?	227	57.0%	245	78.0%
c. Do not change the well-being of society and the environment, and do not cause damages to the páramo ecosystem?	6	1.5%	5	1.6%
d. Do not know/No response	158	39.7%	50	15.9%
<b>Total</b>	<b>398</b>	<b>100.0%</b>	<b>314</b>	<b>100.0%</b>

On the other hand, it is interesting to observe how none of the respondents in Bucaramanga agreed that the mining project would bring more benefits than risks to the páramo, which is explained by the wide dissemination of this issue citywide. This same explanation is valid for Pamplona as well. Another item to note is the high level of those who answered “do not know” or gave no response in cities like Cúcuta (41.6 percent) and Pamplona (38 percent).

Finally, by breaking down the information for the question on the problem of the mining project and its effects on water quality in the Páramo de Santurbán, the analysis of data by department further shows that the population of Santander believes that there is some risk of affecting the water quality of the páramo: 75.8 percent against 39.2 percent of Norte de Santander. However, the proportion in both departments of people who answered that the effect would be moderate and reparable does not exceed 8 percent.

On the other hand, it is important to note the high percentage of respondents of the department of Norte de Santander who answered “do not know/no answer” (40.5 percent), compared to 14.0 percent in Santander, which largely explains the result for the aggregated data (see Table 28).

**Table 28: Regarding the impact of these projects on water quality, do you think that:**

Options	Norte de Santander		Santander	
	Observations	Percentage	Observations	Percentage
a. They put water quality of rivers, watersheds, and streams of Páramo de Santurbán at irreparable risk?	156	39.2%	238	75.8%
b. They put water quality of rivers, watersheds, and streams of Páramo de Santurbán at moderate and reparable risk?	32	8.0%	12	3.8%
c. They put water quality of rivers, watersheds, and streams of Páramo de Santurbán at risk?	49	12.3%	20	6.4%
d. Do not know /no response	161	40.5%	44	14.0%
<b>Total</b>	<b>398</b>	<b>100.0%</b>	<b>314</b>	<b>100.0%</b>

Bucaramanga, on the question about mining risk/impact on the ecosystem, scored the highest in perceived risk of the project on water quality (86.9 percent). Percentages in Cúcuta, Pamplona, and Piedecuesta are much lower: 34.8 percent, 51.0 percent, and 46.3 percent respectively. This is explained by the fact that a significantly higher number of respondents answered “do not know/no response.”

The final set of questions investigated the uses of water resources from the páramo and the quality of drinking water, under the hypothesis that those who use water for multiple purposes and receive a better quality of service will give a high value to the water from the páramo. Regarding uses, Table 29 breaks down the respondents by number of uses given to water resources from other nearby sources, such as lakes, streams, or ponds.

**Table 29: Number of uses declared by water users**

Number of uses	Observations	Percentage
0	1	0.1%
1	662	93.0%
2	45	6.3%
3	3	0.4%
4	1	0.1%
<b>Total</b>	<b>712</b>	<b>100%</b>

**In general, most people just state one single use for water, mainly for household activities permitted by the water from the aqueduct (85.5 percent of respondents). Finally, assessed in three ways: first, in terms of the amount of days a week that the service is for the number of hours a day in which the service is received; and third, by giving a rating the quality of the water supplied by the water company.**

Table 30 below presents the information.

**Table 30: Quality of water from the aqueduct**

Question	Mean	Standard Deviation
Number of days a week that the water service is received by the household	6.315*** (0.0547)	1.5
Number of hours a day that the water service is received by the household	21.57*** (0.209)	5.5
Rating of the quality of the water supplied by the aqueduct company	2.131*** (0.0374)	1.0

Figure in parenthesis is standard error. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

The fact that, on average, citizens are supplied with water most week days is worth highlighting, as is the fact that they receive it for about 21 hours daily. However, the water was rated from fair to good, with an average rating of 2.1 (with a significance level of 99 percent).

## 9.2. THE KNOWLEDGE OF THE PÁRAMO INDEX

The Knowledge of the Páramo Index was built from four questions that inquire about: (1) the knowledge of a páramo, (2) the Páramo de Santurbán, (3) environmental services, and (4) knowledge of the water sources that supply homes. These questions have a dichotomous YES/NO structure, which allowed scoring a YES with a dot, and a NO with a zero (0). Thus, by adding the four questions, the index gives a score between zero (0) and four (4).

After associating a score to each observation, quantiles that divide the sample into three equal parts were defined, in order to build a scale on which to read the results in the best possible manner—high/medium /low. Table 31 shows the relationship between scale and levels of knowledge.

**Table 31: Knowledge Index on the Páramo: knowledge levels and scale**

ICP Index	
Knowledge levels	Scale
Low	[0-2)
Moderate	[2-4)
High	4

### 9.3. THE ENVIRONMENTAL ATTITUDES INDEX

The Attitudes toward the Environment Index (IAA) seeks to measure the level of disposition of respondents towards the environment. The methodology for the construction of this index is similar to the ICP [*Índice de Conocimiento del Páramo* (Index of Páramo Knowledge)]: the score is calculated on four questions using a scale of high/medium/low, based on two quantiles under a minimum score of minus two (-2) and a maximum score of six (6). The negative score corresponds to the inclusion of two questions that, unlike the ICP, scored negatively.

First, respondents were asked whether they had visited a natural recreation site:

*During the past 24 months, have you traveled to a natural recreation site (nature reserve area, National Natural Park, undertaken ecotourism activities)?*

The question scored one (1) or zero (0), depending whether the answer was positive or negative.

Second, a question that highlighted the dilemma between the benefits and risks of the mining project on water resources from the Páramo de Santurbán was built:

**Regarding the impact of these projects (gold extraction mining projects in the Páramo de Santurbán) on the quality of water, do you believe that:**

QUESTION	Score
<b>Regarding the impact of these projects on water quality, do you believe that:</b>	
They put water quality of rivers, watersheds and streams of Páramo de Santurbán at <u>irreparable risk</u> ?	2
They put water quality of rivers, watersheds and streams of Páramo de Santurbán at risk?	2
They put water quality of rivers, watersheds and streams of Páramo de Santurbán at <u>moderate and reparable risk</u> ?	1
Do not know/no response	0

On this question, a positive score was given for any conscious attitude on a risk posed by mining projects on water resources, and a zero (0) on those with a misinformed or reserved opinion—Do not know/No response.

The next two questions inquired whether the respondent agreed with declaring the Páramo de Santurbán a regional natural park, which was scored as one (1) if the answer was Yes, a zero (0) if the answer was Do not know/No response, and a minus one (-1) if the answer was No. The following text corresponds to the question:

*Would you agree that the Páramo de Santurbán should be declared a regional natural park?*

The first question posed the dilemma between the benefits and risks of the mining project on the páramo ecosystem. The question was structured as a reward/penalty; it was scored positively if there was a minimal response indicating a reflection on the issue, and a maximum score of (2) for an attitude that values environmental resources as opposed to the other benefits of the project (where economic benefits stand out). In turn, a score of minus one (-1) was given to an attitude that valued the environmental risks of the mining project to a lesser extent than other benefits. Finally, a score of zero

(0) was awarded to the Do not know/No response answer, since it shows a misinformed opinion that denotes a lack of interest on the subject, ignorance, or a reserved opinion that for various reasons cannot be rewarded or punished.

**Do you believe that these projects (gold mining extraction projects at the Páramo de Santurbán):**

<b>QUESTION. Do you believe that these projects:</b>	<b>Score</b>
Bring more risks than benefits to society and the páramo ecosystem	2
Do not change the well-being of society and the environment, and do not cause damages to the páramo eco system.	1
Do not know/ no response.	0
Bring more benefits than risks to society and the páramo ecosystem.	-1

The following table presents the ratio between scale and levels of knowledge.

**Table 32: Attitude Index towards the Environment: knowledge levels and scale**

<b>IAA Index</b>	
<b>Knowledge Levels</b>	<b>Scale</b>
Low	[-2-3)
Moderate	[3-5)
High	[5-6]

It is important to note that although the scale establishes the possibility of negative values, the sample used for this survey had zero (0) as the minimum scale.

## **9.4. WILLINGNESS TO PAY AS A PROPORTION OF THE WATER BILL AT THE SOCIETAL LEVEL**

**Table 33: Percent of WTP on an average bimonthly payment for water services, according to social level: Bucaramanga**

<b>Social level</b>	<b>Fixed charge – (Pesos)</b>	<b>Basic consumption</b>	<b>Complementar y consumption</b>	<b>Average bimonthly payment</b>	<b>WTP/Average Monthly Payment (Pesos)</b>			
		<b>-M<sup>3</sup>≤20- (Pesos per M<sup>3</sup>)</b>	<b>-M<sup>3</sup>&gt;20- (Pesos per M<sup>3</sup>)</b>	<b>Fixed charge +pesos M<sup>3</sup>* bi-monthly Consumption (Pesos)</b>	<b>3,066</b>	<b>6,180</b>	<b>11,461</b>	<b>17,686</b>
1	3,331.7	635.56	1,271.12	41,465.30	7.4%	15%	28%	43%
2	4,664.37	889.78	1,271.12	47,882.37	6.4%	13%	24%	37%
3	6,330.22	1,207.56	1,271.12	55,903.82	5.5%	11%	21%	32%
4	6,663.39	1,271.12	1,271.12	57,508.19	5.3%	11%	20%	31%
5	9,995.09	1,906.68	1,906.68	86,262.29	3.6%	7%	13%	21%
6	10,661.42	2,033.79	2,033.79	92,013.02	3.3%	7%	12%	19%

Source: Calculations by authors.

**Table 34: Percent of WTP on an average bimonthly payment for water service, according to social level: Cúcuta**

Social level	Fixed charge (Pesos)	Basic consumption	Complementary consumption	Average bi-monthly payment	WTP/Average monthly payment (Pesos)			
					-M <sup>3</sup> ≤20- (Pesos per M <sup>3</sup> )	-M <sup>3</sup> >20- (Pesos per M <sup>3</sup> )	-Fixed charge +Pesos M <sup>3</sup> *bi-monthly Consumption (Pesos)	3,066
1	3,331.70	783.32	1,447.91	47,956.3	6.4%	13%	24%	37%
2	4,664.37	836.89	1,447.91	50,360.37	6.1%	12%	23%	35%
3	6,330.22	1,447.91	1,447.91	64,246.62	4.8%	10%	18%	28%
4	6,663.39	1,447.91	1,447.91	64,579.79	4.7%	10%	18%	27%
5	9,995.09	2,173.31	2,173.31	96,927.49	3.2%	6%	12%	18%
6	10,661.42	2,173.31	2,296.38	100,055.22	3.1%	6%	11%	18%

Source: Calculation by authors

## 9.5. DESCRIPTIVE STATISTICS OF THE PÁRAMO DE SANTURBÁN'S VISITORS

A total of 140 visitors were surveyed in the district of Berlin (Tona) and the municipalities of Pamplona, Cúcuta, Cúchira, Cucutilla, Veta, and Suratá. These areas were chosen for being located in a páramo or close to and having access to one. They were also the most visited due to the presence of lakes and other attractions. A total of 140 surveys were carried out.

The survey included a module that characterized the individual by asking for the place of residence, age, monthly income range, education, and main occupation. In a second module, the respondent was asked about the cost of travel. This section inquires about the number of visits in the last two years, the starting point of the visit, the type of transport used to visit the páramo, the time traveled from the place of origin, and the number of people traveling together. It also inquired about the duration of the visit, the main reason for the trip, and the activities carried out at the Páramo de Santurbán (see section 9.8 for more complete descriptive statistics).

The vast majority of the population surveyed was Colombian (88 percent), followed by Venezuelan (11 percent). Of the Colombian respondents, 73 percent were residents of the region.

Of the 140 respondents, 56 percent were men and the average age of the sample was 34 (see Table 35). A total of 86 percent of respondents have higher education and only 1 percent had not completed secondary education (see Table 36). Most belong to the middle class (87 percent are in social strata 3 and 4) (see

Table 37). By observing the social strata by place of origin of the visit, it was found that in general, visitors from areas farther from the páramo belong to a higher social stratum, which is to be expected because the greater the distance, the higher the cost of the visit.

For the vast majority (82 percent) of respondents, it was the first time visiting the recreational site (see

Table 39). For 52 percent, the main destination of the trip was the Páramo de Santurbán, which implies that the remaining 48 percent considered the visit to the Páramo de Santurbán as a complementary visit to their final destination, but not the primary reason for the trip.

When visitors were asked about the number of people with whom they traveled, including the respondent, the answer was an average of 3.64 (see Table 45). Regarding the duration of the stay, visitors stayed an average of 2.22 days at the páramo; the duration of the stay was on average one day longer when the main destination was the Páramo de Santurbán.

There was a large variance in the cost of the trip per person: the maximum cost reported was 550,000 pesos and the minimum was 30,000 pesos. Visitors reported holidays as the main reason for the trip (70 percent); other common reasons were work and research (9 percent each). When visitors were asked if they were traveling as part of an organized tour or with a travel agency, 41 percent responded positively, while 59 percent traveled independently. With regard to the activities undertaken by visitors, answers included the observation of flora and fauna, hiking, and fishing. In general, visitors carried out more than one activity. When asked about payment for activities, 37 percent reported having paid for their activities.

The visitor survey included a module that asked visitors about conservation. This was to diagnosis a visitor's interest in preserving the páramo ecosystem, particularly the Páramo de Santurbán. Visitors were asked if they knew of the environmental services provided by the Páramo de Santurbán; 62 percent answered affirmatively (see Table 48). When asked about the importance of páramo conservation, 74 percent believed it is "very important" and 26 percent said "important." It is noteworthy that none responded "somewhat important" or "not important" (see

Table 49).

Ninety-two percent of visitors agreed that the Páramo de Santurbán should be declared a regional natural park (see Table 50). However, when asked about the willingness to pay an entrance fee in the hypothetical case that the declaration were actually made, the percentage of respondents willing to pay the entrance fee was lower than the percentage who claimed to agree to declare it a regional natural park.

Under the hypothetical scenario of having the entire Páramo de Santurbán (80,000 ha) declared a regional natural park, 63 percent agreed to pay an entrance fee. The average willingness to pay the fee was estimated at 21,176 pesos.

**Table 35: Age of survey respondents**

	<b>Average age</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Number</b>
Female	33.70	8.479	19	64	61
Male	34.36	9.146	18	56	79
<b>Total</b>	<b>34.08</b>	<b>8.839</b>	<b>18</b>	<b>64</b>	<b>140</b>

**Table 36: Educational level of respondents**

	Female	Male	Total	Percent
No response/ Do not know	1	0	1	1%
Graduate studies	6	13	19	14%
Primary	1	0	1	1%
Professional	38	35	73	52%
Secondary	4	3	7	5%
Technical	11	27	38	27%
<b>Total</b>	<b>61</b>	<b>79</b>	<b>140</b>	<b>100%</b>

**Table 37: Monthly income and average social stratum per income of respondents**

Monthly Income (Pesos)	Average Social Level	Observed	Participation (Percent)
Between 0 and 600,000	3.0	4	3%
600,000 – 1,000,000	2.8	22	19%
1,000,000 – 1,500,000	3.4	37	32%
1,500,000 – 2,000,000	3.7	34	30%
2,000,000 – 3,500,000	3.8	16	14%
3,500,000 – 5,000,000	4.0	1	1%
5,000,000 – 10,000,000	6.0	1	1%
<b>Total</b>	<b>3.4</b>	<b>115</b>	<b>100%</b>

**Table 38: Main occupation of respondents**

Main occupation	Female	Male	Total	Participation (Percent)
Employee	30	36	66	47%
Independent	15	24	39	28%
Household	3	0	3	2%
Student	10	15	25	18%

Unemployed	1	3	4	3%
No response/Do not know	2	1	3	2%
<b>Total</b>	<b>61</b>	<b>79</b>	<b>140</b>	<b>100%</b>

**Table 39: First visit to the Páramo de Santurbán, for respondents**

Is it the first time you have visited the Páramo de Santurbán?	Observed	Participation (Percent)
Yes	115	82%
No	25	18%
<b>Total</b>	<b>140</b>	<b>100%</b>

**Table 40: Number of visits in the last two years, for respondents**

Number of visits in the last two years	Observations	Participation
1	118	86
2	12	9
3	5	4
4	3	2
<b>Total</b>	<b>138</b>	<b>100</b>

**Table 41: Place of origin and main destination of respondents**

<b>Place of origin</b>	<b>Páramo de Santurbán is the main destination (Percent)</b>	<b>Total number of visitors per place of origin</b>
Barranquilla	0%	1
Betulia	0%	1
Bogota	70%	20
Bucaramanga	54%	41
Cali	0%	3
Caracas	100%	2
Cúcuta	87%	23
Duitama	0%	1
El Zulia	0%	1
Ibague	0%	1
Los Patios	0%	1
Medellín	67%	3
Monteria	100%	1
Pamplona	77%	13
Pereira	0%	1
Puerto Wilches	0%	1
San Antonio	100%	1
San Cristobal	100%	5
Sogamoso	0%	1
Tunja	0%	13
Urena	100%	4
Velez	0%	1
Villa del Rosari	0%	1
<b>Total</b>	<b>57.9%</b>	<b>140</b>

**Table 42: Statistics reported per visitor according to area of origin**

Zone	Total cost reported (Pesos)	Cost/day (Pesos)	Main destination is the Páramo de Santurbán (Percent)	Travel time reported (Hours)	Observed	Percent of responded surveys
Bucaramanga	252,250	157,666.7	37	4.82	41	29.3%
Cúcuta	394,500	149,208.3	87	8.00	23	16.4%
Bogotá	567,500	247,368.4	55	10.17	20	14.3%
Tunja/Vélez	294,286	169,285.7	0	9.56	14	10.0%
Pamplona	189,167	105,000	77	9.00	13	9.3%
San Cristóbal/San Antonio/Ureña	533,333	317,129.6	100	6.00	10	7.1%
Medellín	416,667	283,333.3	67	6.50	3	2.1%
Cali	330,000	165,000	0	13.50	3	2.1%
Caracas	600,000	200,000	100	14.00	2	1.4%
Duitama/Sogamoso	310,000	155,000	0	11.50	2	1.4%
Los Patios/Villa del Rosario	600000	300,000	0	5.00	2	1.4%
Ibagué/Pereira	300,000	120,833.3	0	10.50	2	1.4%
El Zulia	600,000	300,000	0	5.00	1	0.7%
Montería	150,000	50,000	100	9.00	1	0.7%
Barranquilla	280,000	280,000	0	16.00	1	0.7%
Betulia	260,000	130,000	0	10.00	1	0.7%
Puerto Wilches	280,000	280,000	0	13.00	1	0.7%
<b>Total</b>	<b>373,983</b>	<b>200,578</b>		<b>10</b>	<b>140</b>	<b>100.0%</b>

**Table 43: Means of transportation of respondents**

Means of transportation	Means of transportation to Páramo de Santurbán when it was the main destination		Transportation to main destination when other than Páramo de Santurbán		Transportation from main destination to Páramo de Santurbán	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Car	29	36%	29	44%	13	20%
Airplane	2	3%	3	5%	0	0%
Bus	37	46%	31	47%	21	32%
Other	1	1%	0	0%	5	8%
Car and airplane	0	0%	1	2%	2	3%
Car and bus	4	5%	1	2%	1	2%
Car and other	1	1%	0	0%	7	11%
Airplane and bus	2	3%	0	0%	1	2%
Airplane and other	3	4%	0	0%	0	0%
Bus and other	1	1%	1	2%	16	24%
<b>Total</b>	<b>80</b>	<b>100%</b>	<b>66</b>	<b>100%</b>	<b>66</b>	<b>100%</b>

**Table 44: Travel time according to main destination of respondents (Hours)**

Variable	Average	Standard Deviation	Minimum	Maximum
When main destination is Páramo de Santurbán	5.51	4.1	2	16
From main destination when it is not Páramo de Santurbán	7.75	3.69	2	16

**Table 45: Number of persons traveling together, as reported by respondents**

Number of persons traveling together (including you)	Observations	Percent
1	5	3.6%
2	28	20.0%
3	39	27.9%
4	37	26.4%
5	15	10.7%
6	13	9.3%
7	1	0.7%
9	1	0.7%
14	1	0.7%
<b>Total</b>	<b>140</b>	<b>100%</b>
Average	3.64	

**Table 46: Reason for the trip, as reported by respondents**

Main reason for the trip	Frequency	Percent
Vacations	98	70.0%
Research	13	9.0%
Work	13	9.0%
Vacation and research	8	6.0%
Work and research	4	3.0%
Other	2	1.0%
Work and vacations	2	1.0%
<b>Total</b>	<b>140</b>	<b>100%</b>

**Table 47: Determining factors for selecting the Páramo de Santurbán, as reported by respondents**

Determinant factors for the visit	Landscape	Distance	Cost	Work	Other
Yes	105	65	46	25	5
No	35	75	94	115	135
Percent	75.0%	46.0%	33.0%	18.0%	4.0%

**Table 48: Knowledge of environmental services reported by respondents, according to education level**

Highest educational level	Knows environmental services of the Páramo de Santurbán (Percent)	Observed
Primary	100.0%	1
Secondary	14.0%	7
Technical	40.0%	35
Professional	72.0%	71
Graduate level	78.0%	18
No response/Do not know	.	6
<b>Total</b>	<b>61.0%</b>	<b>138</b>

**Table 49: Perceived Importance of the páramos as strategic ecosystems**

Importance of conserving the páramos	Frequency	Percent of Respondents
Very important	101	74.0%
Important	35	26.0%
Not very important	0	0.0%
Not at all important	0	0.0%
<b>Total</b>	<b>136</b>	<b>100.0%</b>

**Table 50: Opinion on the declaration of Páramo de Santurbán as a regional natural park, by respondents**

	<b>Agree with the declaration of Páramo de Santurbán as a regional natural park</b>	<b>Observed</b>
Antioquia	100.0%	3
Atlántico	0.0%	1
Boyacá	93.0%	15
Caracas	100.0%	1
Cordoba	100.0%	1
Cundinamarca	100.0%	21
Norte de Santander	94.0%	36
Risaralda	100.0%	1
Santander	86.0%	44
Táchira	91.0%	11
Tolima	100.0%	1
Valle	100.0%	2
Venezuela	100.0%	1
<b>Total</b>	<b>92.0%</b>	<b>138</b>

## 9.6. EXISTENCE AND BEQUEST VALUE SURVEYS

The sample was distributed in such a way that 50.1 percent of respondents were male and 49.9 percent were female, between the ages of 17 and 80 years. The average age of persons in the sample was 40; 49.3 percent belonged to social stratum 3. A total of 61.52 percent had a university degree (technician, undergraduate, graduate), while the majority (70.9 percent) earn more than 600,000 pesos a month.

**Table 51: Descriptive statistics: occupation, social level, education and income**

Occupation	Percent	Social Stratum	Percent	Education	Percent	Income level (Pesos)	Percent
Employee	45.3	1	1.8	Primary	7.1	0 a 600,000	29.1
Unemployed	7.1	2	22.0	Secondary	30.6	600,001 to 1,000,000	18.5
Independent	22.0	3	49.4	Technician	14.7	1,000,001 to 1,500,000	12.4
House chores	6.3	4	17.2	Undergraduate	34.4	1,500,001 to 2,000,000	17.2
Student	12.7	5	5.3	Post-graduate	12.4	2,000,001 to 2,500,000	5.8
Other	1.3	6	3.0	NS/NR	0.8	2,500,001 to 3,500,000	3.5
Retired	5.3	No response/ Do not know	1.3			3,500,001 to 5,000,000	4.3
						5,000,001 to 10,000,000	3.5
						No response/Do not know	5.6

Table 52 below shows the main answers to the module on attitudes regarding the environment. Of the respondents, 53.9 percent stated that they had been at a recreational site in the last 24 months, with an

average of 1.6 visits to similar sites. Regarding concern for the environment, 49.62 percent stated being very concerned. This figure increases as the level of education rises.

**Table 52: Distribution of the concern for the environment according to the level of education**

Level of concern	Distribution per level of education (Percent)				
	Primary	Secondary	Technical	Professional	Graduate
Very concerned	25.0	45.5	51.7	52.9	61.2
Concerned	42.9	42.9	44.8	41.2	20.4
Not very concerned	28.6	6.6	3.5	1.5	4.1
Not at all concerned		0.8			
Don't know/didn't respond	4.6	4.1		4.4	14.3

Consistent with the answers above, the majority of respondents stated that they always separate garbage, turn off the faucet when brushing their teeth, and use efficient light bulbs. However, 49.4 percent never use reusable bags to buy groceries, and 28 percent take more than five minutes to take a shower.

**Table 53: Distribution of the frequency of certain activities related to the concern for the environment**

Action	Always (Percent)	Almost always (Percent)	Sometimes (Percent)	Never (Percent)	No response/Do not know (Percent)
a) Separate garbage	51.6	11.4	14.9	20.5	1.5
b) Turn off the faucet when brushing teeth	85.1	10.1	3.0	0.3	1.5
c) Use low energy bulbs	76.9	7.6	9.6	3.3	2.5
d) Take reusable bags to buy groceries	20.5	4.6	22.8	49.4	2.8
e) Take more than 5 minutes in the shower	28.1	22.5	25.1	22.8	1.5

Finally, the willingness to pay to convert the Páramo de Santurbán into a regional natural park was 24,555 pesos; 61 percent of respondents stated that they would be willing to pay a fee to preserve the páramo. Besides, the majority of persons stated their disagreement with paying a fee to save the páramo. The main reason cited for their unwillingness to pay is a belief that the government should bear the expense of declaring the Páramo de Santurbán to be a regional natural park.

The tables below illustrate the distribution of the willingness to pay according to the initial fee for the preservation of the páramo:

#### When the answer to the initial question is “Yes”

Form	Initial Sum (Pesos)	Percent of affirmative answers	Next Sum (Pesos)	Percent of Yes answers
1	10,000	80.2	20,000	81.5
2	20,000	61.9	40,000	73.3
3	30,000	60.4	60,000	60.3
4	40,000	42.6	80,000	58.1

#### When the answer to the initial question is “No”

Form	Initial sum (Pesos)	Percent of No answers	Next sum (Pesos)	Percent of Yes answers
1	10,000	20	5,000	20.0
2	20,000	38	10,000	8.1
3	30,000	40	15,000	18.4
4	40,000	57	20,000	13.8

#### Distribution of reasons for unwillingness to pay for conservation of Páramo de Santurbán

Response	Percent
The government should pay	59.7
Does not know/ did not respond	28.9
Cannot pay	8.4
Would prefer to protect the area	2.0

## 9.7. BUILDING THE CONCERN INDEX

To build the index on the concern and interest of individuals in preserving the environment, a score of 0 to 3 was awarded to the answers to the following questions:

Question	Answer	Score
How concerned are you about the environment?	Very concerned	3
	Concerned	1
	Not very concerned	1
	Not at all concerned	0
How frequently do you separate the garbage?	Always	3
	Almost always	1
	Sometimes	1
	Never	0
How frequently do you turn off the faucet when you wash your teeth?	Always	3
	Almost always	1
	Sometimes	1
	Never	0
How frequently do you use low energy bulbs?	Always	3
	Almost always	1
	Sometimes	1
	Never	0
How frequently do you take reusable bags to buy groceries?	Always	3
	Almost always	1
	Sometimes	1
	Never	0
How frequently do you take more than 5 minutes in the shower?	Always	0
	Almost always	1
	Sometimes	2
	Never	3

Subsequently, the concern variable was added, which is equal to the sum of the scores of each question. In this way, the highest score possible would be 18, which would reflect the greatest level of concern and interest for the environment (consciously or unconsciously). The lowest score is equal to zero, which would display no interest in natural resources. The answers “no response/do not know” were not taken into account in determining the score for each individual within the index.

## 9.8. DESCRIPTIVE STATISTICS OF THE RESIDENTS OF PÁRAMO DE SANTURBÁN

**Table 54: Income reported according to activity performed by the company or business in which the person works, by municipality<sup>18</sup>**

Municipality	Average income reported (Pesos)	Observations
Arboledas	520,938	103
Agriculture	510,714	39
Trade	600,000	4
Student		28
Field work	570,000	1
House chores		8
Na		1
No response/do not know		21
Health		1
Cachira	712,500	77
Agriculture	760,000	21
Trade		1
Student		25
Community mother	550,000	1
No response/do not know	400,000	29
Cacota	616,667	85
Farm management	600,000	2
Agriculture	610,000	14
Trade	683,333	6
Student		28
Livestock		2
Field work	600,000	9
House chores		9
No response/do not know		9
Several occupations	566,667	3

<sup>18</sup> The list of activities includes "Student" and "Retired." This indicates the reason why some respondents are unemployed.

<b>Municipality</b>	<b>Average income reported (Pesos)</b>	<b>Observations</b>
Retired	600,000	3
California	592,500	115
Agriculture	347,143	8
Trade	200,000	1
Student		35
Livestock		3
House chores		32
Mining	768,333	30
Na		4
No response/do not know		2
Charta	578,750	75
Agriculture	554,615	21
Trade	300,000	1
Student		29
House chores		19
Mining	875,000	3
Na		1
No response/do not know		1
Cucutilla	691,667	102
Agriculture	757,143	17
Trade	575,000	6
Student		21
Field work	700,000	18
House chores		20
Na		7
Family business	800,000	1
No response/do not know		9
Various occupations	800,000	1
Retired		1
Food preparation	400,000	1
Mutiscua	761,538	76
Agriculture	763,636	22
Trade	900,000	4
Student		16
Livestock		3
Field work	600,000	2

<b>Municipality</b>	<b>Average income reported (Pesos)</b>	<b>Observations</b>
House chores		11
Na		2
Ns/nr		14
Retired		1
Fishery		1
Silos	583,333	79
Agriculture	600,000	26
Trade	500,000	5
Student		19
House chores		11
Na		2
No response/do not know		15
Retired	500,000	1
Surata	647,619	97
Farm administration	700,000	1
Agriculture	620,000	26
Agronomy	800,000	5
Trade	600,000	2
Student		25
Field work	800,000	1
House chores		19
Mining		1
Na		3
No response/do not know		11
Various occupations		2
Health		1
Tona	583,636	95
Agriculture	503,333	32
Trade	500,000	3
Student		27
Field work	725,000	5
House chores		12
Na		4
No response/do not know		11
Food preparation		1
Vetas	626,071	113

Municipality	Average income reported (Pesos)	Observations
Agriculture	460,000	9
Trade	125,000	2
Unemployed		1
Student		35
Household		1
House chores		33
Mining	812,500	25
Na		6
Transport	600,000	1
<b>Grand total</b>		<b>1,017</b>

## 9.9. SOCIAL AND DEMOGRAPHIC CHARACTERISTICS OF THE RESIDENTS OF THE PÁRAMO DE SANTURBÁN

This section reports on a household survey of the residents of the Páramo de Santurbán. Two hundred and forty nine surveys were carried out in the páramo municipalities of Arboledas, Cáchira, Cécota, California, Charta, Cucutilla, Mutiscua, Silos, Suratá, Tona, and Vetas. The number of surveys is representative of households in the municipalities of the Páramo de Santurbán with a confidence level of 95 percent. The questionnaire was applied in randomly selected households. The questionnaire collected information on demographic features, social and economic activities, income, and housing.

**Table 55: Surveys by municipality**

Municipality	Number of Surveys	Percent of Total
Arboledas	30	12
Cachira	20	8
Cécota	20	8
California	25	10
Charta	15	6
Cucutilla	29	12
Mutiscua	20	8
Silos	20	8
Suratá	22	9
Tona	23	9
Vetas	25	10
<b>Total</b>	<b>249</b>	<b>100</b>

## **9.10. HOUSEHOLD MEMBERS AND THEIR DESCRIPTION**

The surveys asked questions about the head of household and about other members living in the home. The average household size was 4.08 (2.83 adults and 1.25 children), above the national average of 3.6 people per household.

About 81.4 percent of the respondent household heads were male, and the households were composed mainly of the head of household and spouse, along with children, followed by the parents of the head of household and his grandchildren. The average age of the heads of household was established at 47.6 years and of children at 17.5 years.

Fifty percent of the residents surveyed were male and 30.7 percent were children under age 18. Of the children, 88.2 percent currently attend school and 89.7 percent were literate. The adult population reported an average monthly individual income of 1,000,533 pesos, which is above the minimum individual wage of 2012 (634,500 pesos), including the transportation allowance.

**Table 56: Age, education, gender, and income**

	Age	Gender (Male)	Literacy Rate	Attending School	Income (pesos)
<b>Under age 18</b>					
Average	11.52	48.2%	89.7%	88.2%	\$600,000
Standard Deviation	4.28	50.0%	30.4%	32.3%	\$346,410
Observations	313	313	311	313	3
<b>18 or older</b>					
Average	44.51	50.7%	96.0% <sup>a</sup>	4.7%	\$1,000,533
Standard Deviation	16.98	50.0%	19.6%	21.2%	\$669,809
Observations	704	704	704	704	375
<b>Total</b>					
Average	34.35	50%	94.1%	30.4%	\$997,355
Standard Deviation	20.91	50%	23.6%	46.0%	\$668,563
Observations	1,017	1,017	1,015	1,017	378

<sup>a</sup> The nationwide literacy rate for rural people over 15 years of age is 86.4 percent (DANE 2011).

About 33 percent of the adult population had only completed primary education and 61 percent of the adults had not finished high school. Overall, no significant differences were found between the educational levels of women and men.

Most people over 18 are workers; of these, most are male (78 percent). Of those that are 18 or older, a total of 34.4 percent is dedicated to house chores; of this, over 93 percent are women, indicating that the occupations of women and men differ significantly in the rural population studied. A total of 3.6 percent are unemployed and 3 percent stated that their main occupation was being a student. In terms of revenue, only workers consistently reported a monthly income, averaging 628,373 pesos for those who reported an income. Of the 242 persons engaged in housework, only 8 reported a monthly income, indicating that, in general, these people do not receive income for their work. In terms of age, the average age was higher among the unemployed. Those who reported another activity are the youngest (Table 57). Of the children, 86.9 percent are students.

**Table 57: Main occupation statistics**

Main Occupation	Percent	Percent Male	Average Age	Number of Persons Who Report an Income	Average Monthly Income (Pesos)	Total Average Monthly Income (Pesos)	Observations
Worker	54.1%	78.0%	44.01	356	628,373	587,141	381
House chores	34.4%	6.2%	45.99	8	612,500	20,248	242
Other	4.5%	53.1%	20.63			0	32
Unemployed	3.6%	60.0%	58.96	8	454,000	145,280	25
Student	3.0%	61.9%	54.29	3	80,000	11,429	21
No response/ Do not know	0.4%	0.0%	54.67				3
<b>Grand total</b>	100.0%	50.7%	44.51	378	621,435	333,668	704

The majority of adults were unpaid family workers (37 percent), followed by persons who work their own land (19 percent), self-employed (12 percent), and agricultural workers (8 percent). Only 4 percent of the respondents of age reported being an employee or agricultural worker, which indicated that there is a high rate of labor informality in the region. The majority of minors (under 18 years) reported never having worked.

On the other hand, when asked about the activity performed by the company or business they worked for during the previous month, 49.5 percent of respondents stated working in farming and/or livestock activities and 30.7 percent in house chores. Additionally, it was found that 10.4 percent were dedicated to mining activities. Upon analyzing the data disaggregated by municipality, it was found that for all municipalities (with the exception of Vetás and California) the main economic activities are farming and livestock activities. In Vetás and California, gold mining prevails.

**Table 58: Main activity performed by the company/business worked for last month**

Main Activity	Observations	Percent
Agriculture and livestock	280	49.5%
Agronomy	5	0.9%
Trade	35	6.2%
Housework	174	30.7%
Mining	59	10.4%
Transport	1	0.2%
Food preparation	2	0.4%
Health	2	0.4%
Other	8	1.4%
<b>Total</b>	<b>566</b>	<b>100.0%</b>
No response/Do not know	444	100.0%

The survey found that 97 percent of heads of household are affiliated with a social security system and 58 percent are affiliated with the subsidized system. Moreover, 34.5 percent reported contributing to a pension fund. Of those who do not contribute to a pension fund, 66.4 percent reported lack of money as the reason for not doing so.

To identify whether migration is significant among the residents of the region, heads of household were asked about their place of residence five years ago. The study found that over 80 percent lived in the same municipality now as they did five years before.

Heads of household reported having an average income of 1,165,870 pesos/month. Disaggregating the results according to land tenure and land activities, it is evident that those with land devoted to mining production reported higher incomes than the rest, while those without land or productive activities reported the lowest average incomes.

**Table 59: Income of the heads of household**

Economic Activities Carried Out in the Land Plot (If Any)	Average (Pesos)	Maximum (Pesos)	Minimum (Pesos)	Standard Deviation (Pesos)	Number
Other/none	1,010,000	3,000,000	200,000	477,687	107
Agriculture	1,124,051	3,000,000	400,000	523,601	79
Livestock	1,509,091	4,000,000	600,000	913,345	22
Agriculture and livestock	1,412,903	2,500,000	400,000	624,762	31
Mining	1,762,500	2,800,000	800,000	682,302	8
<b>Total</b>	1,165,870	4,000,000	200,000	598,533	247

As for expenses, the surveyed households reported spending an average of 1,120,403 pesos per month. Households that have land and conduct farming and mining on their properties reported higher spending than households that do not have these features. In total, the main item of expenditure of the households is food (38 percent), followed by costs associated with transport and other expenses. Education and toiletries also play an important role in household spending. Moreover, transport spending of households engaged in farming or mining of their lands is more than twice the spending of those households that are exclusively dedicated to other economic activities. Respondents reported the highest average incomes in Tona and the lowest incomes in Charta.

Fifty-eight percent of respondent households reported having been the beneficiary of a state social program, most commonly *Familias en Accion* (Families in Action) and programs for older adults (

Table 60).

**Table 60: Transfers from social programs**

<b>Program</b>	<b>Observations<sup>a</sup></b>	<b>Percent</b>
<i>Familias en Accion</i>	52	21
<i>Jovenes en Accion</i>	6	2
<i>Sena</i>	12	5
Red Juntos	28	11
Colombian Institute of Family Welfare	4	2
Unemployment subsidy	0	0
Emergency assistance	11	4
Senior citizens assistance	59	24
Displaced populaiton	9	4
Titling of land plots	0	0
<i>Agro Ingreso Seguro</i>	0	0
Other	11	4
None	105	42
<b>Total</b>	<b>297</b>	

<sup>a</sup> Households may benefit from more than one program

## 9.11. HOUSING FEATURES

Surveys on housing characteristics reported that 50 percent of respondents owned and paid for their home, while 9 percent were still paying for their house. Fourteen percent of respondents rented their house and 15 percent were in usufruct. One percent indicated being de facto occupants.

Almost all respondents had electricity services, but access to water was low in the sample of households surveyed as compared to the rest of the country.

**Table 61: Access to public services**

Service	Number	Percent	Coverage Rate <sup>a</sup> (Rest of the Country) (Percent)
Energy	247	99.2	89.9
Natural gas	1	0.4	4.0
Water	82	32.9	53.1
Sewage	36	14.5	12.3
Telephone	20	8.0	33.0
Garbage collection	81	32.5	18.3
No response/Do not know	0	0.0	
<b>Total</b>	<b>249</b>	<b>100.0</b>	<b>.</b>

<sup>a</sup> Source: ECV 2011

The majority (53 percent) of respondents reported that the water they use for drinking and food preparation is obtained from pipelines or communal aqueducts; but, a significant portion (27 percent) gets water from the rivers or streams. Some (10.4 percent) obtained water from the public water supply and the rest from other sources, including wells, rainwater, rivers, or streams.

The predominant flooring material in the sampled homes is tile and cement, while the material of the walls varies among respondents: 32 percent of homes have block or brick walls, 33 percent are made of mud or adobe, and the rest of materials are considered of a lower quality.

Regarding the effects of natural disasters on housing, 18.9 percent of respondents reported having suffered some type of damage. The main types of damages recorded were from floods and avalanches. Respondents most affected by natural disasters live in the municipalities of Cucutilla, Cécota, Mutiscua, and Cáchira, where 72.4 percent, 55 percent, 15 percent, and 15 percent (respectively) of respondent households were affected.

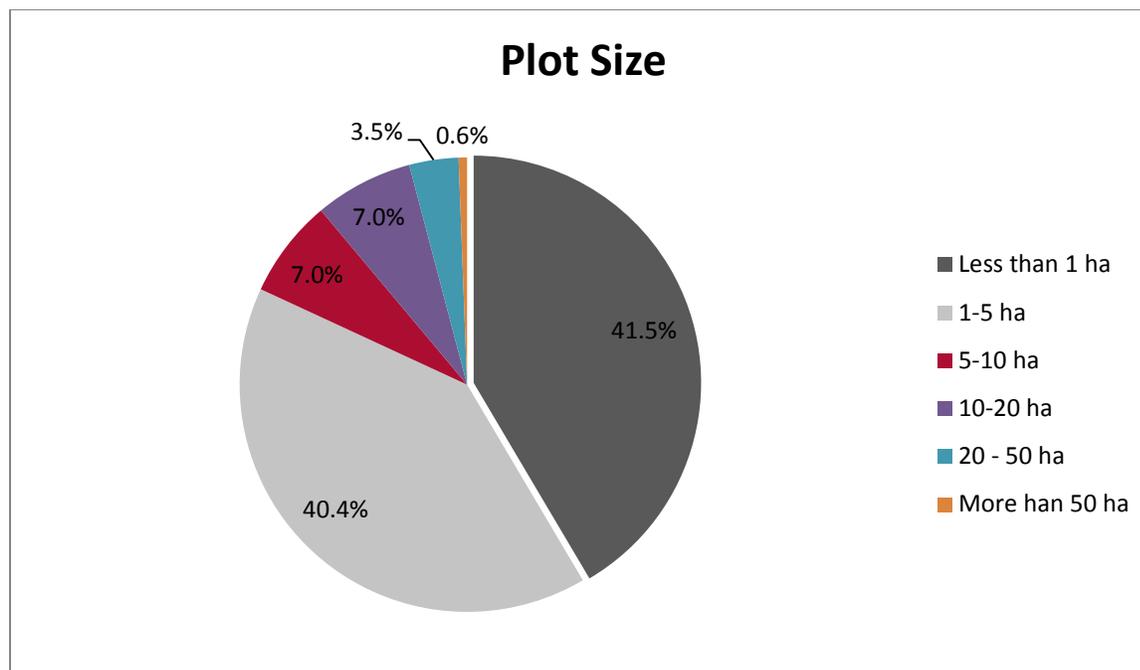
## 9.12. LAND

### 9.12.1 Information on Land Plots

**Of the 249 households surveyed, 202 reported having at least one farm, property, or land are distributed in 12 municipalities. Only 171 respondent households reported the size of plots. Most of these are small plots: 41.5 percent of the farms have an area equal to or less hectare; 89 percent are less than 10 hectares (see**

Figure 14).

**Figure 14: Size of Plots**



Seventy-nine percent of respondent households reported owning their plots. When questioned about problems or conflicts related to land tenure, 40 percent of those who answered the question reported some type of problem. Forty-six percent of the problems are associated with inheritance or succession, while 18 percent are due to close proximity of the land to the park or reserve. Remaining problems are associated with boundaries, disputes with tenants, property titles, and other factors. The properties that have problems due to location in a park or reserve are in the municipalities of Arboledas, Cáchira, Cécota, and Cucutilla.

A total of 42.8 percent of respondents said that their land has its own water sources and that they use it mainly for domestic use and irrigation.

About 65 percent of respondents made some investments between 2008 and 2012. Most of those who made an investment did so in irrigation systems (73 percent) and housing (49 percent), with lesser amounts in permanent and semi-permanent structures and fruit and timber trees. Furthermore, 20 percent of the households reported investments in soil conservation and/or water supply.

## 9.13. ECONOMIC PRODUCTION

Of the respondent households that reported having a farm or lot, 52 percent performed agricultural activities, 25.7 percent livestock activities, and 4 percent mining (see

Table 62).

**Table 62: Main economic activities in household lands**

Economic Activities in Household Lands	The Household Owns Some Type of Farm or Lot					
	No		Yes		Total	
	Number	Percent <sup>a</sup> (%)	Number	Percent <sup>b</sup> (%)	Number	Percent <sup>c</sup> (%)
Agriculture	6	50.0	105	52.0	111	51.9
Livestock	0	0.0	52	25.7	52	24.3
Mining	0	0.0	8	4.0	8	3.7
None	6	50.0	37	18.3	43	20.1
<b>Total</b>	<b>12</b>	<b>100.0</b>	<b>202</b>	<b>100.0</b>	<b>214</b>	<b>100.0</b>

a Percentage based on households that responded not having land.

b Percentage based on households that responded they had land.

c Percentage based on households that responded to the question on land.

### 9.13.1 Agricultural Production

A total of 111 households reported performing agricultural activities in their lands. The agricultural products given the largest amount of land in the last 12 months were potatoes (22.4 percent), berries (17.9 percent), and onions (13.4 percent). Table 63 shows the share of each product in the total number of responses, and lists the municipalities where these products are grown. Coffee and strawberry products were also reported, which are not grown in wilderness areas, indicating that some households farmed land outside the highlands of their municipalities. A field visit found that the main crops cultivated in the páramo were potatoes and onions.

Onions were harvested quarterly, while potatoes were an annual harvest as reported by respondents. Cultivation of these products was carried out in small plots of land; the average cultivated area for onions was 3.1 ha and 1.53 ha for potatoes.

**Table 63: Main agricultural products**

Product	Number	Percent	Municipality
Potato	21	18.8	Cáchira, Cécota, Cucutilla, Mutiscua, Silos, Suratá, Tona, Vetas
Berry	20	17.9	Arboledas, Cécota, Charta, Cucutilla, Suratá
Onion	15	13.4	Tona, Vetas
Peach	13	11.6	Cécota, Cucutilla, Mutiscua, Silo, Suratá
Curuba	10	8.9	Arboledas, Cécota, Mutiscua, Silos
Strawberry	7	6.3	Arboledas, Cécota, Silos
Lulo	7	6.3	Arboledas
Vegetables	5	4.5	Mutiscua
Yellow potato	4	3.6	Cécota, Silos
Tree tomato	4	3.6	Arboledas, Cucutilla
Coffee	3	2.7	Arboledas, Suratá
Beans	2	1.8	Cáchira
Carrot	1	0.9	
<b>Total</b>	112	100.0	

Table 64 and Table 65 show statistics for potato and onion acreage per household, crop yield, quantities consumed by the household, and quantities sold. They also report information on incomes from harvesting and the amount of labor employed. It is important to note that these figures are not statistically significant.

**Table 64: Potato cultivation statistics**

Potato	Lot Area (Ha)	Cultivated Area (Ha)	Production ('000 Kilograms)	Yield. (Tons/ha)	Consumption (Kilograms)	Percent Consumption	Sales ('000 Kilograms)	Percent Sales	Income of Previous Year ('000 Pesos)	Wages (Pesos)	Persons
<b>Average</b>	3.85	1.53	1.26	6.26	151	11.97	1.11	88.03	1,790	50	5
<b>Standard Deviation</b>	5.66	1.46	0.98	10.46	155		1.22		4,293	38	4
<b>Observations</b>	22	23	23	23	21	21	23	23	23	23	22

**Table 65: Onion cultivation statistics**

Onion	Lot Area (Ha)	Cultivated Area (Ha)	Production ('000 Kilograms)	Yield (Tons/ha)	Consumption (Kilograms)	Percent Consumption	Sales ('000 Kilograms)	Percent Sales	Income of Previous Year ('000 Pesos)	Wages (Pesos)	Persons
<b>Average</b>	6.2	3.1	32.40	7.44	786	2.43	31.96	98.63	21,600	59	8
<b>Standard Deviation</b>	5.8	3.4	39.69	4.53	2,654	.	39.36		24,600	90	5
<b>Observations</b>	17	17	17	17	14	14	17	17	17	17	17

Farmers' own capital was the main source of funding for potato cultivation (71.4 percent) and onion cultivation (40 percent). However, they also reported using other sources of funding such as commercial or family loans.

All the potato and onion growers surveyed reported using fertilizers, and 44 percent reported using some type of machinery in their crops. Thirty-six percent reported having some type of irrigation system.

### 9.13.2 Livestock Production

Cattle and sheep are the predominant livestock products in the Páramo de Santurbán. Many of the households with a farm or lot that also have cattle use them to produce milk for home consumption and

sometimes for sale. In some areas of the páramo, particularly in Cáchira, households have sheep that are used primarily for wool production. In livestock production, it is important to note that homes often use both their land area and those outside their boundaries for grazing their animals.

**Table 66: Livestock production income and employment**

	<b>Total Income (Last 12 Months, Pesos)</b>	<b>Days of labor paid (Last 12 Months, Pesos)</b>	<b>Persons Participating in Production</b>	<b>Use of Fortified Food (Percent)</b>	<b>Use of Machinery (Percent)</b>
<b>Average</b>	16,500,000	371.5	4.5	63	4
<b>Standard Deviation</b>	30,300,000	521.0	4.3	-	-
<b>Maximum</b>	168,000,000	2,400	20	-	-
<b>Observations</b>	51	45	51	54	54

### 9.13.3 Mining Production

Eight of the respondents reported carrying out mining activities on their lands; all of them located in the municipalities of Vetas or California (Santander) and all extracting gold. Although official data could not be found, survey respondents indicated that a significant portion of land in the area was sold in 2007 to gold mining companies. From that year, the sale of land has remained stable and new landowners have begun exploration and development works.

On average, 17 grams of gold per day was extracted from each land plot (1.2 grams per day per hectare). Annual sales of the eight properties amounted to 16.2 kg registered annually, which generated total revenues of 1,735,000,000 pesos; 118 people were associated with the production (Table 67). In terms of employee wages, there was confusion by some of the respondents, and wage data appeared inconsistent with data on the number of employees. Nevertheless, numbers can be interpreted as indicating that each miner worked almost every day in mines (approximately 350 days of labor per year).

**Table 67: Gold mining production statistics**

Household	Municipality	Lot Size	Daily Extraction (Grams)	Extraction (Grams/ha)	Sales of Last Year (Grams)	Total Income (Pesos)	Days of labor	Number of Persons Working in Mining
1	California	30	20	0.7	3,000.0	400,000,000	350	20
2	Vetas	2	3	1.5	870.0	61,000,000	840	3
3	California	35	6	0.2	1,814.4	280,000,000	360	30
4	Vetas		5		1,360.8	120,000,000	360	2
5	Vetas	15	80	5.3	5,000.0	400,000,000	360	25
6	Vetas	4	4	1.0	1,152.0	86,000,000	1,080	4
7	California	5	4	0.8	1,170.0	88,000,000	1,120	4
8	California	22	16	0.7	1,814.4	300,000,000	350	30
<b>TOTAL</b>		113	138	1.2	16,181.6	1,735,000,000	4,820	118
<b>Average</b>		16.1	17.3	1.1	2,022.7	216,875,000	602.5	14.8
<b>Standard Deviation</b>		13.3	26.1	2.0	1,371.0	144,114,476	349.7	12.7

The most common sources of funding to develop mining activities were loans from financial institutions and respondents' own resources. In addition to mining on household grounds, two households reported extracting gold from rivers.

#### 9.13.4 Other Economic Activities

In total, 44.2 percent of respondent households reported doing other activities outside farming and mining; of these 45.5 percent also engaged in farming or mining. Among the activities reported by households were equipment rentals, leasing of land, trade in agricultural products, educational services, labor, shops, bakeries and food sales, "chance," and sales of cell phone minutes and gasoline. Non-farming and non-mining activities reportedly yielded an average income of 6,736,364 pesos per year, while for the rest, the figure is 15,386,120 pesos.